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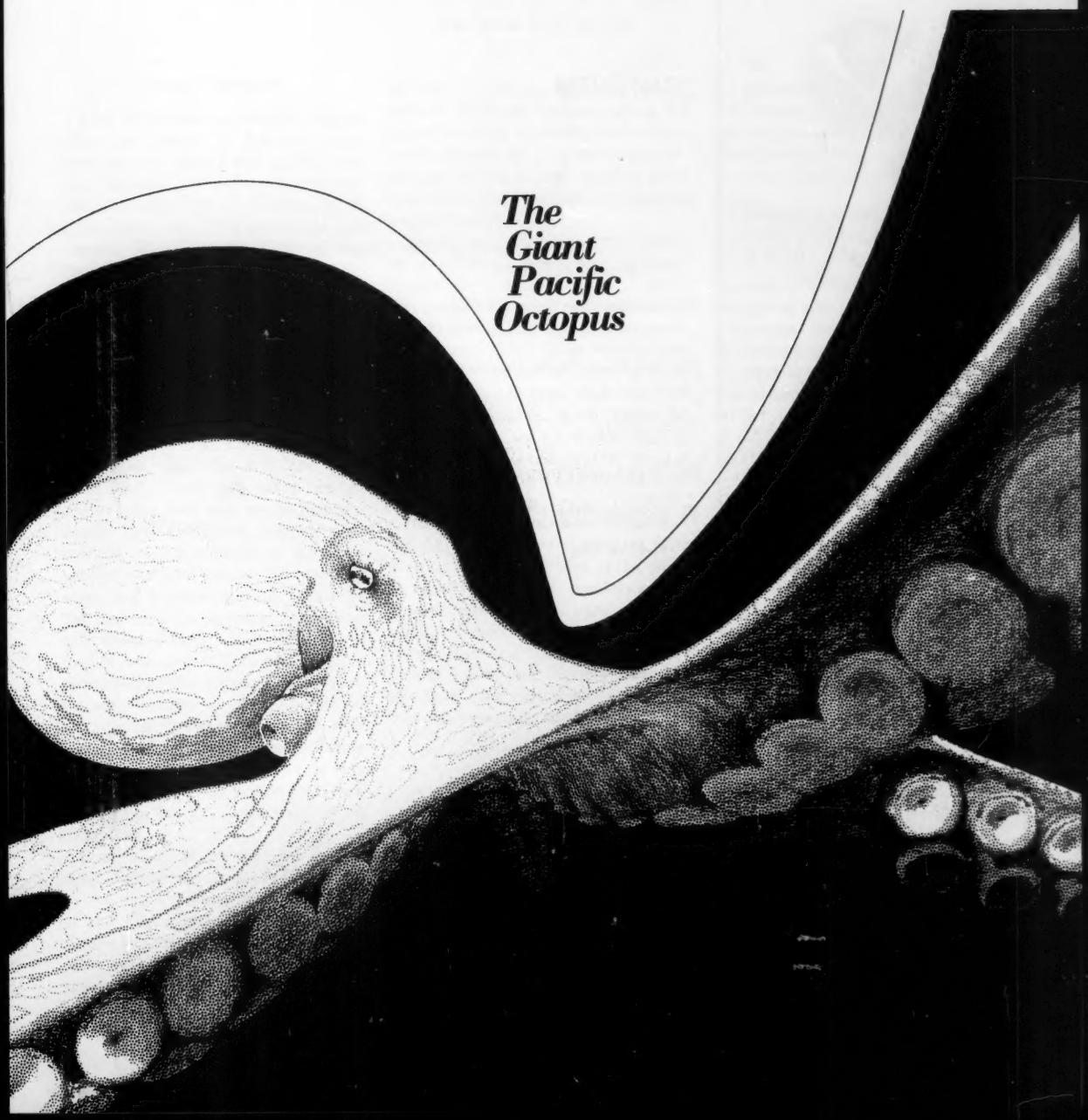
The Giant Pacific Octopus



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MFR PAPER 1198

Chemical Characteristics of Fish Caught in the Northeast Pacific Ocean

MAURICE E. STANSBY

INTRODUCTION

Vast differences in chemical composition are found in fish—not only between one species and another but also between one individual and another, or even between different parts of the same body. This paper will give the reader a general idea of the chemical makeup of the fishery resources of the waters off Oregon, Washington, and Alaska. Differences in the composition of the various species inhabiting these waters will be stressed.

Such differences in chemical composition are due to a variety of factors, most of which lead back to what and how much feed the fish has been consuming. Thus, fish taken during winter when feed may not be plentiful usually have a different chemical composition from individuals of the same species captured during the summer when feed is more plentiful. Similarly, fish that undergo protracted spawning migrations during which little or no feed is consumed will have a chemical composition quite different from fish of the same species taken at other times in their life cycles. Juvenile fish may have chemical compositions differing from those of adults, which in turn may be related to feeding habits—but such differences are apt to be small or inconsistent.

Composition of fish may also depend upon factors not related to feeding habits. For example, the temperature of the water in which the fish live determines the chemical makeup to some extent. This factor goes beyond the influence of environmental temperature upon feed conversion. The temperature of the fish's environment may result in the laying down within the fish of different types of components of which the best example is the type of fat. Fish inhabiting cold waters usually deposit fat of a more unsaturated type, having a lower melting point than fish of the same species living in warmer waters.

There is no doubt that, environmental conditions aside, the different species adapt their chemical composition to conditions which the species encounter during their life cycles. Species which must move about rapidly and over wide distances must provide energy sources to draw upon, and such species will contain much higher fat content (which can be drawn upon as an energy source) than is to be found in fish of more lethargic movements, such as bottom dwellers.

Because of the very wide variation in composition of fish (in order to have even an approximate idea of the effect of such variables as season or geographic area of catch upon composition), a tremendously large number of samples must be analyzed for us to be able to know with any certainty the effects of such variables. Such extensive analyses have not been made for species inhabiting the waters of the northeastern Pacific Ocean. Most of the data presented will be set forth in a species-oriented way to show the range of values encountered throughout the region.

Stansby

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The discussion of composition deals with adult finfish, shellfish, and crustaceans. Nearly all data have been collected in connection with their usefulness to the commercial fisheries. This means there are virtually no data on the composition of larval forms nor of plankton. Furthermore, since no commercial operations have ever been carried out in the region on utilization of seaweed, there are no data upon which we can draw to show the chemical composition of this class of sea life.

In presenting the information, the proximate composition (i.e., the content of moisture, oil (or fat), protein, and ash) will be discussed first. The available data are far more extensive in these types of analyses than for any others. This discussion will be followed by a consideration of the kinds of chemical compounds which make up the broader classes considered in proximate composition. This entails discussion of the amino acid makeup of the protein of fish, the fatty acids present in the oil or fat, and the mineral elements which are collectively reported as ash. Finally, a presentation will be given of chemical components such as vitamins which occur in only trace amounts.

PROXIMATE COMPOSITION

General Considerations

Proximate composition has been widely used as a general assessment of the composition of foods for more than

a century. Proximate composition of American foodfish was determined by Atwater and Wood in a very thorough way, the work being carried out during the early 1870's at Wesleyan University in Connecticut under the sponsorship of the U.S. Commission of Fish and Fisheries, the predecessor agency of National Marine Fisheries Service (Atwater, 1892). The work was exhaustive and complete for most species caught on the Atlantic coast; some species were included from inland waters, such as the Great Lakes. These data are still in general use in tables of food composition which include fish.

Unfortunately, these analyses included very few species taken in the waters off Oregon, Washington, and Alaska. From the early 1930's to the present time, several thousand analyses of the proximate composition of fish inhabiting the waters of the northeastern Pacific Ocean have been made in laboratories of the National Marine Fisheries Service (and predecessor agencies). Some of these analyses have been published by Thurston and others, (Thurston, 1958, 1961a, 1961b, and 1961c; Thurston and MacMaster, 1960; Thurston and Newman, 1962; Karrick and Thurston, 1964 and 1968; and Nelson and Thurston, 1964), but a considerable part of the available data has never been published. The data used in this section are taken from this published and unpublished reservoir of data of the National Marine Fisheries Service.

As has been indicated, although many thousands of analyses have been made of fish in the area of current concern, because of the high variability and many factors involved, the data are sufficient only to establish the general range of values for the different species.

The data are presented in Tables 1 and 2. Table 1 lists the species by common and scientific name. Table 2 gives an idea of the sample size as well as the values found for the proximate composition. The geographic area where the fish were caught, if known, is also given.

The sample size is indicated by giving the number of lots of fish, the number of individual fish, and the number of chemical analyses made. Sampling methods differed, depending upon the person(s) conducting the investigation under different circumstances over a span of more than 40 years. Anywhere from 1 to 50 or more individual fish were procured from some given areas. In some cases all the fish were mixed (after grinding and other preliminary work) together and a single analysis made. In other instances, individual analyses were made upon samples from each fish.

Table 1.—Species of fish analyzed for proximate composition.

Common name	Scientific name
Abalone	*Haliotis*
Albacore	*Thunnus alalunga*
Clam	
Butter	*Saxidomus nuttalli*
Cockle	*Cardium corbis*
Littleneck	*Protothaca staminea*
Cod, Pacific	*Gadus macrocephalus*
Crab	
Dungeness	*Cancer magister*
King	*Paralithodes camschatica*
Cucumber, red, sea	*Stichopus californicus*
Dogfish, spiny	*Squalus acanthias*
Eulachon	*Thaleichthys pacificus*
Flounder	
Arrowtooth	*Atheresthes stomias*
Starry	*Platichthys stellatus*
Geoduck	*Panope generosa*
Halibut, Pacific	*Hippoglossus stenolepis*
Herring, Pacific	*Clupea harengus pallasi*
Lingcod	*Ophiodon elongatus*
Octopus	*Paroctopus hongkongensis*
Oyster	
Japanese	*Crassostrea gigas*
Native	*Ostrea lurida*
Pollock, walleye	*Theragra chalcogramma*
Ratfish	*Hydrolagus colliei*
Rockfish	
Black	*Sebastes melanops*
Darkblotched	*Sebastes crameri*
Rougheye	*Sebastes aleutianus*
Bocaccio	*Sebastes paucispinis*
Chilipepper	*Sebastes goodei*
Flag	*Sebastes rubrivinctus*
Greenstriped	*Sebastes elongatus*
Shortspine thornyhead	*Sebastolobus alascanus*
Canary	*Sebastes pinniger*
Pacific ocean perch	*Sebastes alutus*
Yelloweye[1]	*Sebastes ruberrimus*
Rosy	*Sebastes rosaceus*
Yellowtail	*Sebastes flavidus*
Widow	*Sebastes entomelas*
Sablefish	*Anoplopoma fimbria*
Salmon	
Chum	*Oncorhynchus keta*
Chinook	*Oncorhynchus tshawytscha*
Pink	*Oncorhynchus gorbuscha*
Coho	*Oncorhynchus kisutch*
Sockeye	*Oncorhynchus nerka*
Seal, northern fur	*Callorhinus ursinus*
Sea lion, northern	*Eumetopias jubatus*
Shad, American	*Alosa sapidissima*
Shrimp, pink	*Pandalus borealis*
Skate	*Raja* sp.
Sole	
Dover	*Microstomus pacificus*
English	*Parophrys vetulus*
Flathead	*Hippoglossoides elassodon*
Petrale	*Eopsetta jordani*
Rex	*Glyptocephalus zachirus*
Rock	*Lepidopsetta bilineata*
Sand	*Psettichthys melanostictus*
Yellowfin	*Limanda aspera*
Starfish	
Mottled	*Evasterias troschelii*
Purple	*Pisaster ochraceus*
Sunflower	*Pycnopodia helianthoides*
Trout	
Cutthroat	*Salmo clarki*
Dolly Varden	*Salvelinus malma*
Steelhead	*Salmo gairdneri*

[1] Commonly but erroneously referred to as red snapper.

Analyses were mostly performed upon the edible flesh, by which is meant the skin- and bone-free flesh. Unless otherwise stated in Table 2, the analyses refer to such sampling which, in effect, are similar to the analysis of a skinned fillet. When other than edible flesh was analyzed, notation is given in Table 2, column 1. In some species, especially large fish like Pacific halibut, although skin- and bone-free flesh was used in the analyses, the fish was so large that only a portion was used. In such instances, comments are made under the sections discussing results of different classes of species.

In a general way, as has been found for species taken anywhere in the world, there are general types of fish flesh from the standpoint of protein and oil composition. For nutritional purposes, the species can be classified (Stansby, 1962) as: A) low oil-high protein, where the oil content is under 5 percent and the protein content 15-20 percent; B) medium oil-high protein content, with oil running from 5 to 15 percent and protein, 15-20 percent; C) high oil-low protein, in which oil content exceeds 15 percent and protein is under 15 percent; D) low oil-very high protein, where oil content is under 5 percent and protein is above 20 percent; and E) low oil-low protein, where oil content is under 5 percent and protein under 15 percent.

Category B corresponds to fish having composition comparable to meat. For low calorie diets (as for weight reduction), species of fish in category A are especially desirable because of low calorie content (low oil content—lower than in most meats—yet as high a protein content as in other flesh foods). Fish in category D are especially valuable for individuals requiring high protein content since the protein in these species is at higher levels than in other flesh foods. Most species taken in northeastern Pacific waters are in the desirable categories A, B, or D.

Oil and fat are used interchangeably; hereafter, we will use the term oil. The oil content varies to a greater extent

Table 2.—Proximate composition of fish and shellfish.

Species	Origin of sample	No. of lots	No. of fish	No. of anal.	Percent composition											
					Moisture			Oil			Protein			Ash		
					Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
Abalone, Alaska	SE Alaska	3	72	3	77.5	76.6	76.9	0.7	0.6	0.7	17.5	16.3	17.1	1.8	1.7	1.7
Clam																
Butter	SE Alaska	21	525	21	87.3	79.1	80.0	1.8	0.8	1.23	16.0	9.4	13.0	2.08	1.0	1.7
Cockle	SE Alaska	1	10	3	86.0	79.8	82.4	1.4	0.8	1.0	13.5	10.1	11.8	2.2	1.2	1.6
Little neck	SE Alaska	1	1	1		(79.4)			(1.0)			(13.5)			(2.6)	
Cod																
Grey	Alaska, Wash., & Oreg.	12	113	113	83.2	79.7	81.1	1.10	0.21	0.66	19.1	16.3	17.9	1.65	0.96	1.20
Ling	Wash. & Oreg.	14	105	94	85.1	79.1	81.1	2.31	0.35	0.96	19.4	14.4	17.6	1.31	0.93	1.20
Crab, Dungeness																
(Body)	Wash., Oreg., & N. Calif.	8	84	8	81.3	76.0	78.1	0.92	0.80	0.87	20.4	16.9	19.3	2.02	1.65	1.81
(Leg)	" " " "	8	84	8	81.8	77.3	78.9	0.89	0.72	0.82	20.0	16.3	18.4	2.12	1.78	1.95
Crab, King																
(Body)	Kodiak Isl.	4	?	4	88.8	83.1	86.1	1.10	0.38	0.60	13.9	8.7	11.6	2.64	1.98	2.34
(Leg)	Kodiak Isl.	4	?	4	90.8	78.9	86.0	1.29	0.44	0.69	—	—	13.5	—	—	—
(Composite)	Kodiak Isl.	12	?	12	80.5	78.2	79.6	1.46	0.94	1.16	19.6	16.8	18.2	2.20	1.64	1.89
Cucumber, Red, sea	SE Alaska	1	4	1		(86.2)			(0.6)			(10.6)			(1.7)	
Dogfish (Flesh)	Straits of Juan de Fuca	2	3	3	73.8	68.4	70.6	13.6	12.7	13.4	19.4	14.6	17.4	0.96	0.54	0.80
(Whole fish)	Lower Pug. Sd.	3	9	7	72.9	67.0	69.5	18.3	10.1	15.3	17.2	15.6	16.3	2.03	1.50	1.77
Eulachon	Col. River	1	16	16	81.3	76.5	79.6	8.98	4.58	6.25	15.3	13.2	14.6	1.40	1.12	1.25
Flounder																
Arrowtooth	SE Alaska, Wash., & Oreg.	3	31	31	81.7	76.1	79.5	4.52	0.78	2.30	18.8	16.3	17.7	1.20	0.99	1.11
Starry	SE Alaska, Wash., & Puget Sd.	9	40	31	85.7	78.4	80.3	3.40	0.40	1.40	20.6	13.4	17.3	1.24	1.06	1.12
Geoduck, Alaskan																
(Syphon)	SE Alaska	1	7	5	81.1	75.4	77.2	1.3	0.5	0.8	16.7	14.2	15.9	6.4	1.3	4.6
(Body)	SE Alaska	1	7	5	80.4	77.1	78.8	3.7	2.8	3.2	15.4	14.7	15.0	1.9	1.6	1.8
Halibut, Pacific	Oreg., Wash., & Alaska	26	29	29	81.2	76.5	78.3	3.32	0.39	0.79	22.5	18.1	20.7	1.52	1.22	1.35
Herring (Flesh)	Brit. Col. & Puget Sd.	2	14	2	70.9	70.0	70.7	13.1	10.8	12.5	—	—	16.0	1.37	1.09	1.28
(Whole)	Kodiak, Pr. Wm. Sd., SE Alaska, & Brit. Col.	13	210	69	80.3	59.8	70.8	23.7	2.2	12.9	19.5	14.2	16.4	2.8	1.6	2.4
Octopus	SE Alaska	2	2	2	85.7	84.0	84.9	0.86	0.80	0.83	14.0	12.3	13.2	1.90	1.26	1.58
Oyster																
Japanese	Alaska	2	46	2		(80.5)			(1.26)			(10.4)			(1.43)	
Native	SE Alaska	1	15	1		(86.3)			(0.5)			(10.6)			(1.9)	
Pollock, Pacific	Bering Sea & NE Pacific Ocean off Alaska	4	60	8	82.8	70.3	81.5	1.3	0.6	0.98	19.3	16.4	18.9	2.7	1.1	1.34
Porpoise	Unknown	1	4	4	66.6	63.8	65.2	5.03	3.24	3.86	27.5	25.6	26.4	3.79	3.37	3.56
Ratfish	SE Alaska	1	10	10	83.3	70.3	75.3	18.6	3.1	10.7	16.1	14.0	15.1	2.0	1.2	1.6
Rockfish																
Black	SE Alaska	2	32	32	82.6	75.0	81.0	3.62	0.57	1.84	18.9	16.2	18.7	1.35	1.01	1.17
Blackmouth	SE Alaska	1	12	2	77.4	76.9	77.1	2.28	2.09	2.19	18.9	20.6	19.8	1.23	1.22	1.23
Blacktip	SE Alaska	1	3	1		(79.6)			(1.27)			(19.3)			(1.63)	
Bocaccio	Wash.	1	15	15	81.2	78.6	80.0	1.62	0.80	1.04	19.5	17.6	18.6	1.25	1.15	1.20
Chilipepper	N. Calif.	1	12	12	78.7	75.8	76.5	2.90	1.55	2.35	21.6	19.6	20.8	1.20	1.04	1.10
Flag	Wash.	1	6	2	79.1	78.6	78.9	1.95	1.60	1.78	18.4	17.9	18.2	1.10	1.09	1.10
Greenstriped	Wash. & Oregon	2	30	16	79.5	77.5	78.5	0.74	20.2	0.73	20.8	19.6	20.3	1.35	1.13	1.21
Idiot	Wash. & Oregon	1	13	13	81.8	79.3	80.7	3.38	0.57	1.67	18.3	16.3	17.3	1.17	1.01	1.07
Orange	SE Alaska, Wash. & Oregon	13	110	93	83.1	75.2	79.6	4.10	0.25	1.39	20.6	16.4	18.7	1.47	1.00	1.15
Pacific ocean perch	Wash., Oregon & N. Calif.	17	210	200	81.9	76.1	79.2	4.03	0.36	1.43	20.7	15.1	19.0	1.43	1.00	1.16
Red	SE Alaska	4	9	4	83.0	79.8	51.4	0.23	0.19	0.20	18.1	16.4	17.2	1.20	0.86	1.02
Rosy	Wash.	1	13	2	79.1	79.0	79.1	0.88	0.79	0.84	19.4	19.2	19.3	1.09	1.09	1.09
Yellowtail	Wash. & Oregon	6	52	45	81.0	77.5	79.3	3.45	0.62	1.56	20.1	17.1	18.9	1.42	1.06	1.19
Widow	SE Alaska	1	9	9	79.4	77.3	78.7	2.02	1.08	1.60	20.4	18.8	19.6	1.22	1.14	1.16
Sablefish	SE Alaska, Wash. & Oregon	13	108	107	82.4	63.2	70.7	22.9	2.76	15.1	16.6	10.6	13.8	2.00	0.77	1.09
Salmon																
Chum	Puget Sd.	7	7	7	75.6	71.0	74.1	7.33	2.18	3.86	23.3	20.2	21.3	1.33	1.08	1.18
Chinook	Oregon	3	3	3	—	—	73.1	15.7	7.2	11.5	21.2	17.8	19.5	1.32	1.16	1.28
Pink	SE Alaska, Wash., & Puget Sound	15	73	44	80.1	70.3	75.6	12.1	7.4	4.76	23.2	15.2	19.0	1.90	0.80	1.20
Coho	Wash., Oreg. & Puget Sd.	14	86	86	77.2	67.2	72.6	12.5	1.63	5.31	22.8	20.0	21.7	1.30	1.07	1.21
Sockeye	Brit. Col., Wash., Oregon & Col. Riv.	12	42	42	81.9	61.7	70.0	13.7	1.26	8.55	23.4	17.2	21.3	1.28	1.02	1.18
Seal																
N. fur (Whole)	St. Paul Isl. and proc. (Brit. Col.)	2	9	9	67.3	59.4	64.0	20.0	8.8	14.7	21.6	18.6	20.4	5.48	2.46	4.22
(Meat)	St. Paul Isl.	2	3	3	72.8	71.7	72.3	3.71	2.75	3.23	24.6	24.6	24.6	1.42	1.29	1.36
Sea lion (Meat)	SE Alaska	2	5	5	75.0	74.0	74.3	3.5	1.4	1.66	24.5	21.8	23.2	1.3	1.1	1.16
Shad	Oregon	1	2	1		(71.4)			(7.9)			(18.8)			(1.48)	
Shrimp, pink	SE Alaska & Wash.	5	125	5	82.9	75.5	80.1	1.03	0.80	0.95	21.1	15.9	18.1	1.45	0.89	1.25
Skate	Unknown	1	1	1		(81.8)			(6.05)			(16.3)			(1.68)	
Sole																
Dover	Wash., Oreg. & N. Calif.	11	103	103	91.3	76.5	85.4	3.32	0.39	0.95	22.5	7.1	16.8	1.52	0.91	1.11

(Continued on page 4.)

Table 2.—Proximate composition of fish and shellfish, continued.

Species	Origin of sample	No. of lots	No. of fish	No. of anal.	Percent composition											
					Moisture			Oil			Protein			Ash		
					Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
Sole																
English	Bering Sea, Brit. Col., Wash., Oreg. & Puget Sd.	12	98	12	86.3	75.5	81.4	5.41	0.38	1.36	19.3	12.6	16.8	1.34	0.91	1.12
Flathead	Bering Sea, Brit. Col., Wash., Oreg., & Puget Sd.	4	28	8	83.9	79.8	81.0	1.50	0.55	1.10	19.7	14.9	19.2	1.40	0.96	1.13
Petrale	Oregon	3	33	33	83.0	78.5	80.0	2.26	0.52	0.80	19.9	15.6	17.6	1.31	1.02	1.19
Rex	Wash. & Oregon	4	58	58	84.5	80.8	82.3	3.09	0.35	0.71	18.1	13.9	16.7	1.25	0.95	1.10
Rock	Bering Sea & Puget Sd.	4	15	15	83.3	78.8	80.7	1.30	0.49	0.77	19.8	15.9	19.2	1.30	0.99	1.15
Sand	Puget Sound	2	19	19	84.3	79.9	83.4	0.88	0.38	0.44	19.2	15.5	16.1	1.58	1.05	1.07
Yellowfin	Bering Sea	1	78	1		(82.66)			(1.25)			(17.0)			(1.46)	
Starfish																
Mottled	SE Alaska	1	8	8	71.9	67.9	70.6	1.6	0.6	1.2	14.5	11.0	11.8	19.0	13.2	15.9
Purple	SE Alaska	1	9	9	72.7	70.0	71.4	1.8	1.2	1.5	12.3	8.1	10.0	18.0	13.6	16.6
Sunflower	SE Alaska	1	4	4	88.9	86.5	87.6	0.9	0.6	0.7	6.8	3.9	5.7	6.3	3.8	5.0
Trout																
Cutthroat	Pr. of Wales Isl.	1	8	8	79.5	75.8	78.2	3.2	1.1	1.8	21.9	18.3	19.9	1.5	1.3	1.4
Dolly Varden	Bristol Bay (Lake on island)	2	25	19	79.5	67.6	74.1	10.7	2.0	5.4	21.1	17.5	19.8	1.3	1.2	1.2
Steelhead	SE Alaska	4	33	16	74.3	62.2	68.9	16.4	3.7	9.02	22.8	18.2	21.1	1.40	1.00	1.31
Tuna, albacore (Light meat)	Wash. & Oregon	3	28	28	69.5	59.6	64.9	16.1	5.1	10.3	27.1	21.0	25.0	1.56	1.04	1.26
Tuna, albacore (Dark meat)	Wash. & Oregon	3	28	28	72.0	63.3	68.6	13.9	4.3	8.25	24.0	21.0	22.8	1.29	1.11	1.18

than any other component. In the present work, oil content ranged among the species and samples from 0.2 percent to 23.7 percent. In species from other parts of the country, oil content has been measured as high as 85 percent in the edible flesh. These values thus can range up to more than 400 times.

The moisture content of fish tends to vary inversely with the oil content. The sum of the two usually approximates 80 percent. The protein content of fish usually ranges from 17 to 20 percent. The ash content of fish flesh approximates 1.25 percent, falling occasionally to 1 percent or a little less, sometimes rising to 1.5 percent. The ash content is sometimes erroneously found to be considerably higher where all fine bones have not been eliminated. A small proportion of bone can give rise to considerable error.

Discussion of the voluminous results appearing in Table 2 is according to an arbitrary listing by groups of fisheries in the following section.

Discussion of Results by Species

Salmon and Trout

Salmon species are usually priced in the marketplace proportionally to the intensity of their color, ranking in the following order: 1) chinook (king) and sockeye; 2) coho (silver); 3) pink; and 4) chum. Chinook and sockeye are of similar color; chinook salmon have some individuals with nearly colorless flesh which are known as white kings. The color of the different species is usually proportional to the oil content, species ranking for average oil content in the same order: chinook, 11.5 percent; sockeye, 8.6 percent; coho, 5.3 percent; pink, 4.8 percent; and chum, 3.9 percent. The relationship between oil and color is fortuitous and does not apply to white kings, which, although much lighter in color than their red counterparts, have equal oil content. Trout are of much lighter color than the salmon but may have considerable oil content (especially the steelhead trout which averages 9 percent).

The red pigment in salmon, astacin, is readily oxidized, and salmon stored for long periods (such as in the frozen state) gradually lose the red color as a result of such oxidation. Astacin and other pigments may also give rise to changes in color, e.g., red to orange or to brown as a result of oxidation.

The fatty acids of salmon oils of the different species have differing degrees of stability against oxidation, an important property for retaining higher quality during storage. Table 3 lists oils of several species of salmon and trout, showing two indices of such stability: 1) the sum of C22:6 and C20:5 fatty acids (the most highly polyunsaturated and, therefore, most unstable, which occur in fish oils), and 2) the iodine number, an arbitrary fat constant proportional to stability.

Table 3.—Stability of Pacific salmon and rainbow trout oils.

Species	Total % C22:6 and C20:5 fatty acids	Iodine #
Pink salmon	32.4	154
Coho salmon	25.8	139
Rainbow trout	24.0	unknown
Chum salmon	22.8	138
Chinook salmon	14.1	118
Sockeye salmon	unknown	118

Stability toward oxidation increases as one descends the list in Table 3. Pink salmon oil is so unstable that this species cannot be held successfully in the frozen state for more than a few weeks. On the other hand, chinook salmon oil at the bottom of the list is so stable that mild-cured (salted) chinook salmon can be held successfully at above-freezing temperatures for many months without objectionable rancidity problems.

The protein content of salmon and trout is somewhat higher than that of the average fish. Whereas most species of fish average about 16-18.5 percent protein, some falling as low as 15 percent or less, salmon and trout usually contain about 20 percent. Sockeye and coho salmon as well as steelhead trout are especially high, averaging above 21 percent protein.

Flatfishes

Chemical contents of halibut are perhaps less representative for this species

than are those of any other. This is because halibut are often very large and a relatively expensive fish. In analyzing most species, the cost of grinding the edible flesh of each fish in the sample is not a major problem. With halibut, where a single fish may weigh up to 100 pounds, the sampling cost makes the usual procedure unfeasible. Thus, samples were procured by removing several small pieces from a halibut "fletch." A fletch is the meat from a halibut, somewhat analogous to a fillet. By taking a small portion of such a fletch from different parts, at least an approximation of the representative chemical composition was reached.

Halibut have a proximate composition of remarkably uniform range. With an average oil content of 0.79 percent, only 3 of the 29 fish analyzed had values more than 50 percent higher than this amount (1.20 percent, 1.73 percent, and 3.32 percent oil); only one fish had an oil content as little as one-half of the average. The protein content of halibut is higher than that for most species, averaging 20.7 percent for the 29 samples analyzed. Again, the range of protein content, as of oil, was quite uniform. None of the samples contained as much as one-tenth higher protein content than the average, and only one sample had a value this much lower.

Flatfish other than halibut (i.e., the flounders and sole) have proximate composition similar to halibut with respect to oil content but have considerably less protein. The protein content was about average for the species tested in general; for all of the species of flounder and sole analyzed, the protein content averaged 17.2 percent. The protein content for flounder and sole varied to a much greater extent than for halibut, with values ranging from 7.1 to 22.5 percent.

As a class, flatfish have a composition similar to that of most bottom-feeding fish in which the oil content is relatively low and protein content is generally average. Because such fish usually do not migrate over wide areas, there is not the need to store fat in their muscular tissue as an energy source. Hence, large variations in oil content are not found.

Rockfish

Rockfish include members of the Scorpaenidae family. Many genera have similar properties but differ rather widely in external appearance and sometimes in other properties. These fish were first extensively fished during World War II because of a protein shortage. Annual landings on the Pacific coast rose from a few million pounds to over 60 million pounds. After the war and protein shortages declined, the catch declined.

Volume of landings was bolstered, however, well above prewar levels owing to new marketing practices, whereby the most widely available variety, *Sebastes alutus*, began to be marketed under the name of Pacific ocean perch. The related species, *Sebastes marinus*, on the Atlantic Coast had been sold as ocean perch, attracting demand in the middle west where lake fish, such as yellow perch, had been widely known and highly prized. When the Food and Drug Administration permitted sale of this species to be sold as ocean perch, resulting in vast increases in its utilization, the fishing industry sought and obtained authorization to market *Sebastes alutus* as Pacific ocean perch. This halted the drastic downward trend in sale of rockfish and stabilized the market in subsequent years.

The average composition of the 14 species of rockfish, for which proximate composition values are available (Table 2), is moisture, 79.2 percent; oil, 1.42 percent; protein, 19.0 percent; and ash, 1.15 percent. Among the rockfishes, seven make up the bulk of the commercial catch, designated in Table 4 by an asterisk (*). Four of these have closely similar chemical composition to the average values, with Pacific ocean perch being very close to the average. Two others of the commercially common rockfishes have significantly more oil content and one has significantly less.

Pacific ocean perch is estimated to make up about 25 percent of the standing stock of rockfishes off the coasts of Alaska, Washington, Oregon, and northern California. It is less abundant in the waters of the Pacific Northwest than at the peak harvesting periods in past years. In Alaskan waters it, together with the shortspine thornyhead, makes up the vast predominance of rockfish. Pacific ocean perch remains by far the major species landed by American fishers. Canary and yellowtail rockfish are the two most important landed from off the continental shelf adjacent to Washington and Oregon, and each of these species has typical chemical composition. The shortspine thornyhead, also of typical composition, in addition to being abundant in Alaskan waters, is a major variety in the commercial catches in the continental shelf area off northern California and in the continental slope fishing area off Washington and Oregon. This latter fishery also has abundant stocks of Pacific ocean perch and of darkblotched rockfish. The latter variety is of significantly higher fat content than the average rockfish. Other important varieties taken in the northern California fishery include bocaccio—significantly less high in oil than average—and darkblotched rockfish, as well as chilipepper, both higher in oil content than average.

A species of rockfish highly prized in markets of the Pacific Northwest and Alaska by some is the yelloweye rockfish. It is widely (but erroneously) sold as red snapper and is sometimes referred to as red cod. It has, by far, the lowest oil content of any of the rockfish—around 0.2 percent. Perhaps partly because of this very low oil content it has a different texture, somewhat resembling that of crab meat.

Black rockfish was once one of the most abundant varieties but landings have declined in recent years. It has

Table 4.—Comparison of composition of different varieties of rockfish with that of the average of all rockfish varieties.

Species[1]	Average composition	Significantly lower oil content	Significantly higher oil content
Shortspine thornyhead*	X	—	—
Canary*	X	—	—
Pacific ocean perch*	X	—	—
Yellowtail*	X	—	—
Bocaccio*	—	X	—
Chilipepper*	—	—	X
Darkblotched*	—	—	X
Black	—	—	X
Greenstriped	—	X	—
Yelloweye[2]	—	X	—
Rosy	—	X	—

[1]Asterisk opposite name indicates it to be one of the most abundant varieties commercially.
[2]Commonly but erroneously referred to as red snapper.

considerably higher oil content than most other rockfish.

Miscellaneous Finfish

In the group classified as miscellaneous finfish, two extreme types are included. One is the miscellaneous bottom fish: Pacific cod, lingcod, and walleye pollock. The other is a group consisting of Pacific herring, American shad, eulachon, and albacore, which are of a more pelagic type, resulting in a more variable composition, especially with regard to oil content. Sablefish, sometimes referred to as black cod, are often considered to be bottom fish, but because they spend a part of their lives off the bottom and migrate considerably, their composition is closer to that of the miscellaneous pelagic species. Thus, they will be considered here under this latter category.

The three bottom fish, Pacific cod, lingcod, and walleye pollock, have compositions fairly similar to that of the flatfish previously discussed. They have an average oil content of 0.87 percent, ranging from 0.21 to 2.31 percent. Protein content averages 18.1 percent, ranging from 14.4 to 18.1 percent.

In contrast to the latter group, the remaining species, Pacific herring, American shad, eulachon, albacore tuna, and sablefish, have wide ranges of oil content within species and a wide inter-species range of protein content. Oil content averages 10.5 percent, ranging from 2.20 percent to 23.7 percent. Protein content averages 17.7 percent, ranging from 10.6 to 27.1 percent. The oil content for this group is unusually high and the protein content about average.

Albacore is almost unique among the many species of fish inhabiting northeastern Pacific waters in regard to its extremely high protein content. The average protein content for the light meat (the variety of meat used for the canned product) is 25.0 percent, ranging from 21.0 to 27.1 percent. This is an unusually high value for any species, almost half again higher than for most others. The oil content of albacore is high for species of fish in general (just over 10 percent) but is unusually high for tuna. The oil content of other varieties of tuna (not generally found in the northeastern Pacific Ocean) usually is well under 5 percent, often as little as 1 percent. Tuna, except for albacore, is not a fat fish. The canned product contains added vegetable oil which leads the general public to think of it as a fairly fat variety of fish.

Sablefish flesh is near the top of the list with respect to oil content among all common species. Its average of 15.1 percent oil is exceeded to any great extent by only one rather unusual freshwater species of fish, the siscowet trout of Lake Superior, the average oil content of which exceeds 50 percent. Although sablefish is an extremely oily variety, this trait is not always recognized. High oil content species are usually highly susceptible to oxidation. Consumers generally recognize a fish as oily by the flavor, resulting from early stages of oxidation. But sablefish are remarkably stable against oxidation and the oil is almost tasteless. This lack of "oily flavor" sometimes makes it appear that sablefish contain much less oil than indicated by analysis.

Unutilized and Miscellaneous Trash Fish

Many marine fish are not used commercially, but we have only scattered information about most of them. Some efforts have been made to utilize such fish for human consumption or to land large quantities for manufacture of fish meal. A few such species are included in this section, for which limited analytical data are available.

Efforts have repeatedly been made in the Pacific Northwest to utilize the flesh of the spiny dogfish for food—a species extensively used in other countries. In the State of Washington, the dogfish is utilized to a limited extent, together with other species such as skate and ratfish, to manufacture fish meal. The flesh of dogfish in a small sample analyzed was found to contain about 13 percent oil and 17.4 percent protein; nonprotein nitrogen content was 1.7 percent urea and 0.14 percent trimethylamine. The presence of considerable urea in dogfish and other sharks is of concern, especially if it is not separately determined. The urea makes the shark appear to have a much higher protein content than actually present. Thus, in the analysis just cited for dogfish, ignoring the presence of urea would have indicated a protein content of 19.9 percent as contrasted to the actual 17.4 percent.

An analysis of 10 ratfish (analyzed as whole fish) showed an average protein content of about 15 percent, ranging from 14 to 16 percent; oil content averaged 10.7 percent, ranging from 3.1 to 18.6 percent. Analysis of a single whole skate showed 6.3 percent oil and 16.3 percent protein. In view of the inadequate sample size these values are atypical.

Efforts have been made to market the sea cucumber as food. Analyses of four such samples showed 10.6 percent protein and 0.6 percent oil.

Average protein contents of three species of starfish were 11.8 percent, 5.7 percent, and 10.0 percent, respectively, for the mottled, sunflower, and purple varieties. Oil content was low (0.7-1.5 percent).

Shellfish and Crustaceans

One would predict that, if there is to be any large differences composition of different species of marine organisms, these would show up most prominently between major classes such as shellfish and crustaceans as contrasted to finfishes. While there are indeed such differences, they are not as great as one might expect. In chemical composition, shellfish differ considerably compared with crustaceans; in this section these will, therefore, be considered separately.

Shellfish. Included in shellfish composition listings (for which sufficient analytical data are available) are oysters, several varieties of clams, abalone, and octopus. It is unfortunate that no data could be found on razor clams, a species of some importance in Oregon. Data available on oysters are also not as extensive as the importance of the species would warrant.

As a class, the chemical composition of shellfish of the northeastern Pacific Ocean is, as contrasted to that of finfish, much lower in protein content. The oil content is uniformly low. Protein averages 13.4 percent, ranging from 9.4 to 17.4 percent. Oil content averages 1.17 percent, ranging from 0.5 to 3.7 percent. Ash content is definitely higher than in finfish, with an average of 2.10 percent. The higher ash content could conceivably be due,

at least in part, to small residue of shell not completely eliminated during the shucking process.

Clams, with a protein content around 13 percent have considerably higher proportions of this important component than do oysters, which average around 10.5 percent. Oil content is uniformly low in both oysters and clams with an average content near 1 percent. Geoduck, introduced in recent years as a commercial product, is somewhat higher in protein than other clams, averaging close to 16 percent. Oil content in its siphon portion was similar to that of other clams, but in the body meat oil was found to be much higher, or about 3 percent.

Limited analyses of Alaskan abalone and octopus, neither of which has much commercial importance in the Pacific Northwest or Alaska, indicate that abalone is higher in protein than either oyster or clam, with an average of 17 percent. Octopus seems to have about the same protein content (13 percent) as clam. Oil content for both species falls somewhat under 1 percent.

Oysters, both Japanese and native, have similar protein content, close to 10.5 percent. In the somewhat limited samples for which analytical data were available, the native oysters had lower oil content (0.5 percent) than did the Japanese variety (1.27 percent).

Crustaceans. Analyses were made on both king and Dungeness crab. Although there was no consistent difference in chemical composition between these varieties, king crab protein composition appeared to be much more variable than that of Dungeness crab. Dungeness protein content varied from 16.3 to 20.4 percent, while king crab meat protein content varied from 11.6 to 19.6 percent. The average protein content of Dungeness crab was 18.8 percent. With the limited sampling and high variation encountered in the king crab, estimation of typical protein content is very difficult, but it is undoubtedly lower than that of the Dungeness variety. The oil content of both Dungeness and king crab was uniformly low, near 1 percent.

The composition of pink shrimp indicated it was similar to that of Dungeness crab. Protein content of the shrimp averaged 18.1 percent, ranging from 15.9 to 21.1 percent. Oil content averaged 0.95 percent, ranging from 0.80 to 1.03 percent.

Marine Mammals

Marine mammals are taken rarely for their meat; ordinarily they are captured for some byproduct such as fur or oil. Need for information on the proximate composition of these animals has not been manifested. Hence, little data are available. A problem exists as to just what should be analyzed. As with other large animals, chemical compositions between different parts vary greatly. A layer of blubber has an entirely different composition from a layer of muscle or an organ. In considering proximate composition of marine mammals, we need especially to pay attention to how the sample was taken and to interpret the results in terms of to what aspect the results are to be applied.

The northern fur seal, whose fur is used commercially, has been analyzed for proximate composition from meat and whole carcass samples. The raw meat gave a proximate composition not much different from that of flesh from a typical lean finfish: moisture, 72.3 percent; oil, 3.23 percent; protein, 24.6 percent and ash, 1.36 percent. The protein content was somewhat higher than in most finfish. Whole carcasses of the northern fur seal, probably due to the presence of more blubber, gave drastically different proximate composition: moisture, 64 percent; oil, 14.7 percent; protein, 20.4 percent; and ash, 4.22 percent.

Meat from sea lion flesh had proximate composition similar to that of meat from the northern fur seal: moisture, 74.3 percent; oil, 1.66 percent; protein, 23.2 percent; and ash, 1.16 percent. Porpoise, analyzed from a composite of four muscle portions from the back (but including a girdle of blubber and the entire liver), gave a somewhat different composition than parallel meat analyses for other species sampled in a more conventional way: moisture, 65.2 percent; oil, 3.86 percent; protein, 26.4 percent; and ash, 3.56 percent.

Proximate Composition of Different Parts of Fish

In this section will be discussed the differences in proximate composition obtained, dependent upon what part of a fish was sampled. A fish may be ground up completely, employing for the sample the fish in its entirety including skin or shell. Alternately, only edible portions such as the meat or flesh may be used as the sample. Furthermore, fish flesh taken from different parts may vary to a considerable extent. This may be a matter of the kind of flesh throughout the fish. There are in most fish two different kinds of flesh, the light and the dark, both edible but often of rather different chemical composition. The same kind of flesh may have a considerably different chemical composition when taken from near the head, for example, as compared to near the tail.

Location of Oil in Fish Tissue

Oil is the component of fish flesh which varies to the greatest extent. If we consider first where the oil in fish tissue is located it may be easiest to understand factors controlling variation of composition from one part to another of the fish.

Some oil is closely associated with the cellular structure of all fish tissue. To the extent of about 0.2 percent, oil (occurring largely as phospholipid) exists throughout all of the fish flesh. In addition to this minimal amount, oil occurs to a greater or lesser extent either throughout the flesh or sometimes in fat deposits. Some of this fat occurs in most tissue, interspersed fairly uniformly with muscle. Oil also occurs in special locations in much larger amounts. Usually, immediately beneath the skin—especially beneath the lateral line—but also along the top of the back (dorsal area), there may be fatty layers. Another location where thick layers of primarily fatty tissue can be located is along the abdominal wall.

In addition to the locations outlined above, there is a general decline in the amount of oil dispersed in the flesh, decreasing from the head end of the fish toward the tail. Muscle used for extensive activity, such as swimming, in fish is concentrated at the tail. This muscle is apt to have considerably less oil dispersed in it than in less active muscle toward the head. Tissue in the head itself, e.g., in the flesh of the cheeks, are apt to be the tissue having a relatively high oil content.

If slices (steaks) are taken at intervals from head to tail of any fairly fat fish such as salmon, the oil content declines, with slices at the head end often having several times the oil content of slices at the tail end.

Muscle

The light muscle of fish is usually white (in salmon it is pink) while the dark muscle is grey to black. It has sometimes been believed that the oil content of dark muscle of fish is always higher than that of the light muscle. This is not necessarily true. In some circumstances the light muscle has somewhat higher oil content. Perhaps the illusion that dark muscle is always higher in oil stems from the fact that most of the dark muscle occurs immediately beneath the skin at points where there are apt also to be deposits of fat. In salmon, however, the dark muscle is apt to be of higher oil content than that of the light muscle. Sometimes this difference is very pronounced.

In one study of pink salmon, the dark meat contained 12.5 percent oil while the light meat contained only 2.1 percent. With other species the difference may be much less or even reversed. In one series of analysis of 28 albacore tuna, the light meat contained an average of 10.3 percent oil, compared to 8.25 percent oil in the dark meat. The ranges of oil were as follows: light meat, 5.1-16.1 percent; dark meat, 4.3-13.9 percent. Thus, there can be no generalization as to relative oil content between dark and light meat, although differences, such as cited above on pink salmon, may be very great in certain circumstances.

Bone and Shell

The bone and shell of fish have compositions quite different from that of the edible flesh, especially the mineral content. The percentage of ash is much higher in bone or shell. Whole fish will, therefore, have much higher ash content than the edible flesh. In preparation of the edible flesh, unless all fine bones or traces of shell are removed, deceptively high ash content may appear to be present in the flesh.

Although fish bone is higher in ash and lower in moisture than the flesh, it may be higher in protein than the flesh. Thus, the bone may be one of the richest sources of nutrients, high not only in calcium and other nutritionally important minerals, but also in protein. Actually, the bone protein is different from that in the flesh and, in some cases, may not have such a good distribution of amino acids.

Differences in proximate composition of whole fish, edible flesh, and trimmings are typified by the following analysis of Dover sole:

	Moisture	Oil	Protein	Ash
Edible flesh	83.6%	0.8%	15.2%	1.1%
Whole fish	81.9	3.5	12.7	2.7
Nonedible portion	81.2	4.4	11.7	3.5

Subcomponents of Major Constituents

In the preceding section have been discussed the several major classes of compounds which together comprise proximate composition. Most of these major classes consist of components having various subcomponents. The proteins, in addition to belonging to a number of separate protein classifications, are composed of different amino acids. The oil of fish consists of different classes, such as triglycerides and phospholipids, each of which contains different subcomponents such as fatty acids. Finally, the ash contains different elements, such as sodium, calcium, sulfur, etc., and these in turn were present in the fish in different chemical forms. This section will discuss these subcomponents.

We do not have nearly enough information about the chemistry of different species of fish to enable us to pinpoint information about these subcomponents by species specific to the northeastern Pacific Ocean. In this section, therefore, discussions will be on a general basis applicable to most species.

Proteins

Fish proteins are of many varieties, with the type being associated with the function it performs. Sometimes proteins are classified in a general way with respect to their solubility. On an overall basis most of the proteins (70-90 percent) in fish are soluble in salt solutions of the class known as globulins, while another 10-20 percent are water soluble of the type known as albumins. The remaining fish proteins are of the insoluble type such as collagens and keratins.

Muscle proteins of fish consist primarily of myosin (50 percent) and actin (20 percent) which, during muscle contraction, combine to produce actomyosin. Connective tissue, cartilage, and skin contain considerable quantities of collagens. Important proteins with which small quantities of iron are combined include the myoglobin of dark muscle and the hemoglobin of blood. Lipoproteins consisting of lipids combined with protein are important blood constituents and occur in roe. The classes of proteins in fish have been reviewed by Hamoir (1951).

All proteins are made up from amino acids of which at least 21 occur in significant amounts. Table 5 lists the content of amino acids in the flesh and in three common proteins of fish. Those amino acids followed by an asterisk (*) are essential amino acids, i.e., they are not synthesized in vivo and thus must be obtained from exogenous sources. Fish proteins have a good balance of essential amino acids and are not significantly deficient in any, as are many of the vegetable proteins.

Table 5.—Amino acids in fish flesh and protein (from Stansby, 1967).

Amino acid[1]	Percent flesh	Composition		
		Myosin	Actin	Collagen
Alanine	7.1	6.5	5.4	10.4
Arginine	6.9	6.7	7.4	9.1
Aspartic acid	11.2	11.5	9.7	7.5
Cystine	1.4	0.9	1.3	0.0
Glutamic acid	16.9	21.7	13.3	11.3
Glycine	5.1	3.4	5.0	28.2
Histidine	3.6	2.1	3.3	1.2
Hydroxylysine	0.0	0.0	0.0	1.0
Hydroxyproline	0.0	0.0	0.0	9.0
Isoleucine*	5.0	4.6	7.7	1.7
Leucine*	9.2	9.4	6.6	3.2
Lysine*	10.6	10.6	6.5	3.7
Methionine*	2.7	3.0	4.1	2.0
Phenylalanine*	4.7	3.9	4.6	2.0
Proline	4.4	3.5	6.0	12.4
Serine	5.8	4.9	5.9	7.9
Threonine*	5.5	4.3	6.9	0.6
Tryptophane*	1.4	0.8	1.6	0.0
Tyrosine	4.1	2.7	6.0	0.6
Valine*	5.8	5.3	5.9	2.3

[1]Asterisk indicates essential amino acid.

Oils

Fish oils consist for the most part of triglycerides and phospholipids, the former usually making up the bulk of the oil. Other classes of compounds may be present in small amounts

except for a few species where the other classes may be considerable. In many elasmobranch fishes, alkoxydiglycerides may occur in considerable amounts. A few species of fish contain large quantities of wax esters. Many liver oils, especially of elasmobranch fishes, may contain large quantities of hydrocarbons, especially squalene and, in some cases, pristane.

Triglycerides, phospholipids, and several of the other less usual classes of lipids are made up with fatty acids as the most prevalent building block. Just as numerous amino acids make up the building blocks of protein, many fatty acids combine in different proportions in triglycerides or other components of fish oils. The fatty acids differ chiefly in two respects: 1) the chain lengths (i.e., number of carbon atoms), and 2) the extent of unsaturation (i.e., the number of double bonds). Fish oils have a much wider variety of fatty acids than occur in most other edible oils. Many vegetable oils may have only three or four major fatty acids with, in some cases, a single fatty acid comprising more than half of the oil. Fish oils, on the other hand, usually have about 16 major fatty acids and, often, hundreds of others which may occur in small or trace amounts.

The fatty acids of fish oils also differ from those in other fats and oils by being more unsaturated, i.e., in having more double bonds per molecule. Animal and vegetable oils, with only a few exceptions, have no more than four double bonds per molecule (there are ordinarily only small quantities of fatty acids with more than two double bonds). Fish oils may have one-fourth or more of these fatty acids with five or six double bonds; the proportion may run, in some cases, up to 50 percent. Seldom, if ever, is it under 10 percent. The carbon chain length in some fatty acids of fish oils is also somewhat longer than those commonly present in other oils. Lengths above 20 carbons rarely occur in any but fish oils where a chain length of 22 carbons is common.

Table 6 lists the fatty acid composition of the oils of some species of fish taken in the northeastern Pacific Ocean. The fatty acid composition has as yet been determined for only a part of the major species of commercial importance.

Inorganic Elements (Ash)

The ash reported under proximate composition of fish consists of oxides of the various inorganic elements, which may have been present in the fish. Some such elements (e.g., sulfer) may form volatile oxides and be lost during the ashing process so that the approximately 1.25 percent found in most fish flesh ash represents minimal amounts. A different and more complex analysis is needed to reveal the amounts of the different, individual elements present in fish. Such analyses are seldom performed so that we have little information to draw upon to consider the content of the chemical elements in various species. Table 7 lists average composition of various inorganic elements.

Because of interest in recent years in keeping the diet of certain patients low in sodium, there have been several papers published on the sodium and sometimes on the potassium content of fish flesh. Table 8 gives data on the content of these two elements in the flesh of 13 species of fish from the northeastern Pacific Ocean.

Much fish during preparation for marketing are treated with a weak brine at some stage of processing. Frozen fish are often dipped in brine to minimize drip formation during frozen storage. Canned fish often have salt added as a flavor component, making the sodium content of the canned products often more than double that in the fish as it comes from the water.

Not much is known about precisely what form inorganic elements are present in fish. Some components such as sodium and potassium doubtlessly occur largely as inorganic electrolytes. Others such as phosphorous occur both in the ionic form and organically combined, such as in phospholipids. Several

Table 7.—Inorganic elements in the edible flesh of fish (from Stansby, 1963).

Mineral element	Average content (mg %)	Mineral element	Average content (mg%)
Potassium	300	Iron	1.5
Chloride	200	Manganese	1
Phosphorous	200	Zinc	1
Sulfur	200	Fluorine	0.5
Sodium	63	Arsenic	0.4
Magnesium	25	Copper	0.1
Calcium	15	Iodine	0.1

Table 6.—Fatty acid composition (Stansby, 1967 and 1969) of some oils from fish of the northeastern Pacific Ocean.

Species	Fatty acid content (%)[1]															
	14:0	15:0	16:0	16:1	17:0	18:0	18:1	18:2	18:3	18:4	20:1	20:4	20:5	22:1	22:5	22:6
Clam, littleneck	3.2	0.8	23.8	9.6	1.3	5.4	10.8	1.4	1.6	3.0	3.5	1.7	10.0	2.6	1.7	14.5
Cod, Pacific	1.0	+[2]	18.2	3.6	NK[3]	4.7	14.5	1.0	[4]	NK	[4]2.0	[5]	17.9	[5]5.6	1.9	29.2
Dogfish, spiny	2.0	0.5	21.2	6.0	1.2	2.7	27.5	1.3	0.6	0.7	5.8	2.5	7.9	4.1	2.3	10.4
Dogfish, spiny	1.6	0.2	23.5	5.7	0.9	3.0	33.6	0.6	0.5	NK	6.4	2.8	6.5	3.5	1.7	7.0
Halibut, Pacific	2.8	0.3	15.1	8.9	0.7	3.4	25.7	0.9	0.3	3.6	8.0	2.5	10.1	5.1	1.8	7.9
Herring, Pacific	7.6	0.4	18.3	8.3	0.5	2.2	16.9	1.6	0.6	2.8	9.4	0.4	8.6	11.8	1.3	7.6
Oyster, Pacific	2.7	0.9	21.4	4.6	1.4	4.0	8.5	1.2	1.6	4.3	+	1.9	21.5	2.6	1.0	20.2
Rockfish	4.1	0.6	14.9	6.6	2.6	6.0	20.8	1.6	0.8	1.3	1.4	1.5	11.7	0.8	1.6	17.4
Sablefish	4.1	0.5	14.8	11.6	1.0	3.8	38.0	2.1	1.3	NK	6.6?	1.0	4.6	4.1?	NK	2.2
Salmon																
Chinook	3.7	0.4	16.6	9.2	1.1	5.8	29.1	1.1	0.9	1.5	4.7	0.5	8.2	3.6	2.4	5.9
Chum	2.2	0.6	17.0	4.1	1.1	3.2	21.4	2.0	1.0	2.0	5.4	0.9	6.7	9.4	2.3	16.1
Coho	3.7	0.5	10.2	6.7	0.9	4.7	18.6	1.2	0.6	2.1	8.4	0.9	12.0	5.5	2.9	13.8
Pink	3.4	1.0	10.2	5.0	1.6	4.4	17.6	1.6	1.1	2.9	4.0	0.7	13.5	3.5	3.1	18.9
Trout, rainbow	2.1	0.8	11.9	8.2	1.5	4.1	19.8	4.6	5.2	1.5	3.0	2.2	5.0	1.3	2.6	19.0
Albacore	3.7	1.0	29.3	6.3	1.2	6.1	16.6	0.7	0.6	2.2	2.7	1.2	6.5	2.0	0.8	17.6

[1]The figure before the colon is chain length; that after is the number of double bonds.
[2]+ = Trace amounts.
[3]NK = Not known.
[4]Combined 18:3 and 20:1 acids.
[5]Combined 20:4 and 22:1 acids.

Table 8.—Sodium, potassium, and ash content of certain species from northeastern Pacific Ocean (from Thurston, 1958).

Species	Place of capture	No. of fish in sample	Ash (%)	Sodium[1]	Potassium
Albacore	Washington coast	6	1.18	34	293
Pacific halibut	Alaska coast	10	1.50	53	379
Lingcod	Washington coast	6	1.23	62	352
Yellowtail rockfish	Washington coast	6	1.20	50	358
Yelloweye rockfish	Washington coast	6	1.28	66	413
Black rockfish	Washington coast	6	1.28	66	432
Canary rockfish	Washington coast	6	1.26	71	347
Pink salmon	Burroughs Bay, Alaska	12	1.15	76	290
Pacific cod	Washington coast	6	1.22	76	372
Pacific ocean perch	Washington coast	6	1.03	79	324
Starry flounder	Washington coast	6	1.14	85	285
English sole	Vancouver Island	6	1.21	91	330
Petrale sole	Vancouver Island	6	1.12	96	268

[1]Data in mg/100 g.

of the trace elements, such as iron, copper, and arsenic are probably organically combined for the most part. Mercury in fish occurs largely as methyl mercury.

Trace Components

In addition to the major components of water (moisture), protein, oil, and mineral water (ash), fish contain innumerable substances ranging in amounts from a few parts per billion up to a few tenths percent, which we can classify as trace components. It is not possible to even mention many of these substances, but some discussion is included here on three important groups of these components: nonprotein nitrogen, vitamins, and pigments.

From the standpoint of the amounts present, nonprotein nitrogen components are the most important of the classes not already discussed. The nonprotein nitrogen compounds occurring in fish which have been reviewed by Shewan (1951) occur in teleost fishes around 10-15 percent of the total nitrogen in the fish (a little more in herring types of fish). In the elasmobranch fishes these compounds make up a far larger proportion, up to 40 percent, of the total nitrogen. This is due to the occurrence in the elasmobranch fishes of considerable quantities (around 2 percent) of urea.

One of the most important nonprotein nitrogen components of most fish is trimethyl amine oxide which plays an important role in nitrogen metabolism. In marine teleost fishes, this compound is believed to be involved in mechanisms for regulating osmotic pressure. Groninger (1959), who reviewed the occurrence and significance of trimethyl amine oxide, gives the values shown in Table 9 for the content of this substance in various classes of fishes. The elasmobranch fishes contain the most (0.66 percent), about 2 to 4 times as much as other classes of marine fishes and about 20 times as much as freshwater teleosts.

Another important nonprotein compound occurring in considerable quantity in the muscle of fish is creatine. Data compiled by Shewan (1951) indicates that this substance makes up from 0.3 to 0.7 percent of the muscle tissue of a wide variety of fishes (elasmobranch teleosts, molluscs, and crustacea). Urea, which has been noted above as occurring in high concentrations in elasmobranch fishes, is present in only small amounts in teleost fishes, the amounts ranging from 0.5 to 14.5 mg per 100 g (Shewan, 1951).

Table 9.—Content of trimethylamine oxide in different classes of fishes according to Groninger (1959).

Type of fish or shellfish	No. of species	Concentration (mg/100 g) Range	Mean
Molluscs	35	0.0- 955	172
Crustacea	18	14.7- 515	211
Elasmobranch	19	142.0-1,340	659
Marine teleosts	72	0.0- 700	269
Freshwater teleosts	21	0.0- 83	37

In an earlier section the amino acid content of protein was discussed. It should be pointed out here that in all fish, small amounts of amino acids occur in the free state uncombined as protein. The amino acids arginine und histidine have been reported to occur in the free state, the latter at levels around 200 mg per 100 g of wet tissue (Yudaev, 1950).

Vitamins occur in fish associated either with oil (vitamins A, D, and E) or in the case of water-soluble vitamins, with the flesh. The fat-soluble vitamins generally occur in a species of fish in proportion to the fat content of the tissue and are, therefore, higher in amount depending on the oil content of the particular sample. Table 10 gives an indication of the average amounts of vitamins contained in fish.

The pigments of fish are largely carotenoids which are also the principal pigments in plants and animals. Carotenoids are of two chemical types: carotenes, which are hydrocarbons; and xanthophyls which, in addition to hydrogen and carbon, also contain oxygen. The pigments of fish are primarily three compounds of the xanthophyl type: astaxanthine, taraxanthine, and lutein. Most species contain

Table 10.—Vitamin content of edible flesh of fish (Stansby, 1963).

Vitamin	Units	Content per 100 grams Average	Usual range Low	Usual range High
Vitamin A[1]	Micrograms	25	10	100
B vitamins				
Thiamine	Micrograms	50	10	100
Riboflavin	Micrograms	120	40	700
Nicotinic acid	Milligrams	3	0.5	12
Vitamin B12	Micrograms	1	0.1	15
Panthothenic acid	Milligrams	0.5	0.1	1
Pyridoxine[2]	Micrograms	500	50	1,000
Biotin[2]	Micrograms	5	0.001	8
Folic acid[2]	Micrograms	80	71	87
Ascorbic acid (vitamin C)	Milligrams	3	1	20
Vitamin D	Micrograms	15	6	30
Vitamin E (total tocopherol)[1,2]	Micrograms	12	4	35

[1]For fish of medium or high oil content.
[2]Based on very scanty data.

lutein and either astaxanthine or taraxanthine but not both.

Astaxanthine is the pigment responsible for the color of salmon flesh. It is also present in crustaceans where it is generally combined with protein in which form it has a blue or green color. Upon heating with water, the protein bond is broken, releasing the red astaxanthine. These pigments are found in nearly all fish in the skin where they occur inthe esterified forms. Goodwin (1951) reviewed the occurrence and function of carotenoids in fish.

Composition and Nutritional Properties

In foregoing sections emphasis was placed on chemical composition with some incidental mention of its relationship to nutritional properties. Some of the main features of nutritional properties of fish will be summarized here, both with respect to constrasting these properties of fish with that of other foods and with some reference to these properties as they occur in fish of the northeastern Pacific Ocean.

Fish have protein composition in general similar to that of other flesh foods such as meat rather than that in vegetables. The protein is well-balanced with respect to amino acids. Lipids, containing essential fatty acids, are present, but there are little or no carbohydrates. From these standpoints all species of fish are similar.

Some species of fish have characteristics somewhat different from those of other flesh foods which make them more desirable for certain nutritional needs. These relate to: 1) the selection of a food high in protein yet low in calories; and 2) as a source of high quality protein combined with a source of polyunsaturated oil, desirable when serum cholesterol level must be minimized—such as for patients with heart ailments. These properties have been reviewed in a recent report (Stansby, 1973). A variety of species are available with high protein of good nutritional properties, yet having such low oil content that the calories per pound are considerably less than is the case with other flesh foods. Other species of fish serve the second-mentioned dietary need by providing high quantities of highly polyunsaturated oil, which can lower or control serum cholesterol levels (Pfeifer, 1967; Stansby, 1969).

Fish in the northeastern Pacific Ocean provide species for both nutritional needs. Flatfishes, crab, and cod have excellent combinations of low calorific content with high protein. Of fish containing high cholesterol-lowering properties, the various species of salmon are unexcelled. Nelson (1972) provided dramatic evidence of the ability of heart patients to prolong life by adhering to dietary regimens where salmon was a principal source of polyunsaturates.

ACKNOWLEDGMENT

A considerable proportion of the unpublished data upon which results reported here are based were obtained by the late William Clegg, who ran proximate composition of many thousands of fish samples. Much of this work was carried out in the late 1930's and 1940's. We are greatly indebted to Mr. Clegg for his meticulous analytical work and for the fine records he kept which enables the belated publication on his important work.

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MFR PAPER 1199

Seasonal Variations in Chemical Composition and Protein Quality of Menhaden

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and ANTHONY BIMBO

ABSTRACT—Proximate chemical composition of menhaden collected during the course of four different fishing seasons is presented. Atlantic menhaden, Brevoortia tyrannus, *had an abnormally low oil content during the latter half of the 1972 season, probably due to environmental effects of Hurricane Agnes. Fish protein concentrates were prepared from both the Atlantic menhaden and the Gulf menhaden,* B. patronus, *samples collected during 1972 and were evaluated by rat bioassay. Fatty acid compositions of the extracted fish oils were determined by gas-liquid chromatography. No seasonal trend in protein quality was detected, but there was a trend toward a higher proportion of saturated fatty acids during the course of the season.*

INTRODUCTION

Menhaden are the raw material from which most of the fish meal, solubles, and oil are produced in the United States. Approximately half of the total tonnage of finfish landed in the United States is menhaden. During 1974 almost 1.3 billion pounds of Gulf menhaden, *Brevoortia patronus*, were taken from the Gulf of Mexico and 683 million pounds of Atlantic menhaden, *B. tyrannus*, were harvested (National Marine Fisheries Service, 1975). The total value of the combined Atlantic and Gulf menhaden harvests was estimated at $66.4 million. This compares with a value in excess of $71 million for only 247.7 million pounds of yellowfin tuna, *Thunnus albacares*, the tonnage leader among food fish.

Recently, interest has heightened in the potential for utilization of menhaden in higher-valued products. Possible uses which are currently being considered include menhaden hydrolysates for incorporation into milk replacers or microbiological culture media and fish protein concentrates or isolates for use as protein supplements. The human food uses are considered a longer term possibility.

After initial work with red hake, *Urophycis chuss*, the National Marine Fisheries Service (NMFS), then the Bureau of Commercial Fisheries, utilized menhaden in the development of the fish protein concentrate (FPC) process. Produced hygienically by isopropyl alcohol extraction of menhaden, FPC was approved as a food additive by the Food and Drug Administration (Federal Register, 1970).

The purpose of this study was to obtain basic information on the seasonal variations in chemical composition and protein quality of Atlantic and Gulf menhaden for potential FPC production as well as for fish meal and oil production purposes.

MATERIALS AND METHODS

The data obtained consist of two parts. Seasonal data on proximate composition of Atlantic menhaden from the Chesapeake Bay area were collected by Haynie Products, Inc. (now Zapata Haynie Corporation[1]) from 1967 to 1969. During the 1972 fishing season both Atlantic and Gulf menhaden were analyzed at the Southeast Utilization Research Center, NMFS. The FPC's were prepared from the 1972 samples and the extracted fish oils were analyzed for fatty acid patterns.

Menhaden Samples, 1967-69

Whole Atlantic menhaden were sampled directly from the fishing vessel prior to unloading at the dock of the Zapata Haynie plant at Cape Charles, Va. Two boats were inspected to estimate the average size of fish from the day's catch. From the hold of a third vessel, fish of approximately the same average size were selected at random. In most cases the fish were less than 4 hours old when prepared for analysis at the plant. They were cut into smaller pieces and ground through a meat grinder. Each sample was a composite of three whole fish. Sampling frequency varied with fishing activity and ranged from 2 to 15 samples per month.

Menhaden Samples, 1972

Approximately 50-100 pounds of whole menhaden from Chesapeake Bay were selected in the same manner as above from an unloading area at Reedville, Va. The fish were immediately iced and transported to the Southeast Utilization Research Center, College Park Laboratory, College Park, Md. Upon arrival at the laboratory about 40 to 50 fish were randomly sampled for length and weight. The fish were then frozen in polyethylene bags at −20°C

[1]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

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and stored until required. During this sampling period, only one to two samples were obtained monthly.

Fish received from the Gulf of Mexico were obtained by personnel of the NMFS Pascagoula Fishery Products Technology Laboratory, Pascagoula, Miss. The sampled fish were frozen prior to shipping to the College Park Laboratory. These fish, upon arrival, were placed in a refrigerated (5°C) room overnight for partial thawing so as to remove individual fish for length-weight measurements.

Fish Protein Concentrate

Twenty pounds of frozen fish from each 1972 sample were removed from the freezer and processed by isopropyl alcohol extraction into FPC. The extraction process was as described by Dubrow et al. (1970) in which the authors found the process to have no significant effect on the nutritive value of the fish protein. Therefore, the FPC's were submitted to rat-feeding studies to estimate the seasonal variation in the nutritive quality of the menhaden protein.

Analytical Methods

Samples of fish during 1967 to 1969 were analyzed for crude protein by the Kjeldahl technique (Horowitz, 1965), and for moisture and fat content by the methods of Salle (1958).

The 1972 samples of fish and FPC were analyzed for crude protein (Horowitz, 1965). Moisture was determined by drying a 2-g sample in a forced draft oven for 16 hours at 100°C. Samples were ashed overnight in a muffle furnace at 600°C. Fat content was determined using a chloroform:methanol extraction procedure (Smith, Ambrose, and Knobl, 1964).

Protein quality of the FPC produced from the 1972 menhaden was determined in a rat-feeding study. The diets contained 10 percent protein supplied by FPC and the reference diet contained casein. The protein efficiency ratio (PER = wt. gained/wt. protein consumed) was calculated at the end of 4 weeks of feeding. The fatty acid composition of the raw fish oil extracted in the FPC process was determined by gas-liquid chromatography (GLC) of methyl esters prepared as described by Gauglitz and Lehman (1963). A diethylene glycol succinate polyester (DEGS) column was used. Identification of fatty acid esters was as described by Ackman and Burgher (1965).

RESULTS AND DISCUSSION

Analytical: 1967-69 Menhaden Samples

Table 1 shows the proximate composition of Atlantic menhaden sampled during the fishing seasons of 1967-69. The protein content of the raw whole fish ranged between 14.5 and 17.02 percent during these periods. This range is similar to that reported by Thompson (1966) for Gulf menhaden. The oil content showed monthly variations increasing from a low in June to a peak in October. These changes are shown in Figure 1, which shows the average lipid content by month during the three years of sampling. Fish landed during the early part of the season had a lipid content of about 8-10 percent, whereas at the peak month of October, the lipid content was about 20

Table 1.—Proximate composition of Chesapeake Bay Atlantic menhaden sampled during fishing seasons 1967-69.

Date	No. samples	Protein $\bar{x} \pm SD$ (%)	Lipid $\bar{x} \pm SD$ (%)	Moisture $\bar{x} \pm SD$ (%)
1967				
June	2	16.70 ± 0.85	7.87 ± 2.20	69.62 ± 2.03
July	15	17.02 ± 0.92	9.05 ± 3.24	69.40 ± 3.22
Aug.	8	15.67 ± 1.22	13.34 ± 2.46	69.94 ± 2.67
Sept.	2	14.50 ± 0.14	16.55 ± 0.56	65.55 ± 0.78
1968				
July	12	16.45 ± 0.74	8.23 ± 4.65	69.50 ± 4.48
Aug.	10	16.01 ± 1.40	14.36 ± 6.09	64.20 ± 4.75
Sept.	6	14.84 ± 0.93	15.97 ± 4.38	63.60 ± 4.64
Oct.	12	15.10 ± 0.93	20.81 ± 3.89	59.37 ± 2.81
Nov.	6	16.25 ± 0.83	18.24 ± 2.19	60.78 ± 2.54
1969				
June	7	15.76 ± 0.87	10.08 ± 4.18	69.34 ± 4.23
July	8	16.56 ± 3.07	15.13 ± 6.78	65.46 ± 6.17
Aug.	12	16.20 ± 1.31	16.13 ± 4.85	64.87 ± 4.16
Oct.	2	15.75 ± 0.18	20.75 ± 0.39	—

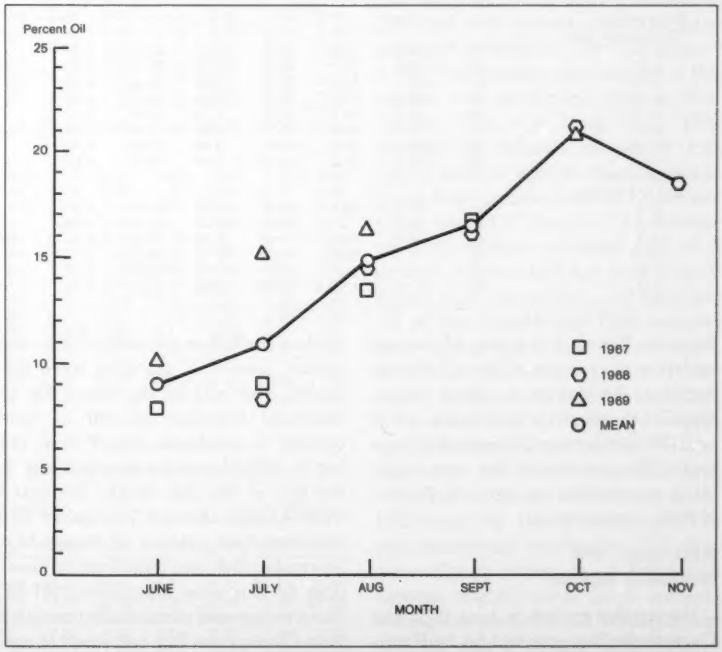

Figure 1.—Average oil content of Atlantic manhaden by month of harvest, 1967-69 fishing seasons.

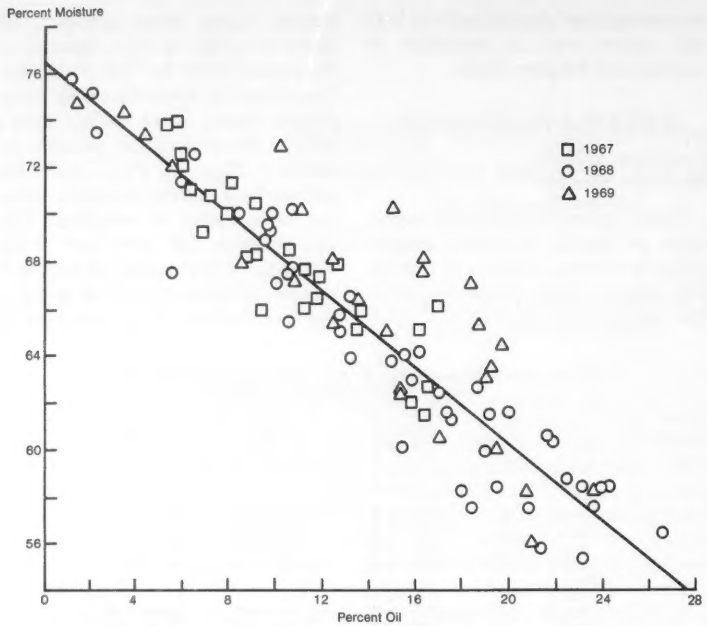

Figure 2.—Moisture content of Atlantic menhaden samples, 1967-69, versus oil content.

Table 2.—Proximate composition and size of Atlantic and Gulf menhaden sampled during 1972 season.

Date	No. sampled	Avg. weight (g)	Avg. length (cm)	Protein (%)	Lipid (%)	Moisture (%)	Ash (%)
B. tyrannus (Chesapeake Bay)							
6/15	52	455.4	29.2	16.78	12.77	66.58	3.84
6/27	33	402.0	28.7	15.70	17.90	62.40	4.20
7/25	40	460.7	30.1	16.42	10.60	66.20	4.90
8/30	86	305.3	27.2	16.75	10.64	69.37	5.46
9/19	51	126.5	19.7	16.88	4.34	74.98	4.42
10/6	51	122.8	18.9	17.14	4.01	72.56	5.68
10/27	50	107.5	18.7	15.91	2.46	77.61	4.42
11/17	50	157.9	20.2	16.19	4.36	75.70	4.67
B. patronus (Gulf of Mexico)							
6/2	50	84.4	15.8	15.05	15.24	65.19	4.27
7/27	32	85.8	—	16.99	17.44	62.40	4.25
9/12	40	136.0	18.1	14.62	23.90	59.45	4.53
10/10	35	72.8	15.6	16.97	12.29	66.55	5.16
11/9	50	78.7	15.6	16.97	13.78	65.68	4.53
12/3	50	117.5	17.5	16.92	10.58	68.01	4.56

percent. Figure 2 is a plot of percent moisture vs. percent oil for all 1967-69 samples. As expected, there was a significant negative correlation ($r = -0.9198$) between moisture and oil contents. The regression line was calculated as: percent moisture = 76.47 − (0.800) x (percent oil).

Analytical: 1972 Menhaden Samples

During this project in June 1972, the Chesapeake Bay area was hit by Hurricane Agnes. The decrease in salinity in the bay as a result of the storm had a profound effect on the native flora, and normal species of plankton were displaced. This may be the reason for an abnormal seasonal pattern of lipid content in menhaden taken from the bay in 1972. As can be seen in Table 2, the size of the fish caught decreased from August through November and the total lipid content of September-November fish was significantly lower than for the same months in 1967-69. The average size of menhaden sampled from Chesapeake Bay decreased sharply over a 3-month period from a weight of 460.7 g in July to a weight less than one-quarter as great on October 27th. There was a partial recovery in size in the November catch. There is normally a general northward movement of menhaden along the Atlantic Coast during the summer (Dryfoos, Cheek, and Kroger, 1973). There may well have been an abnormal migration of the larger menhaden due to the decrease in salinity in the bay in 1972. The lower oil content found in the fish was evidently a reflection of the smaller menhaden fish left in the harvesting areas around the Chesapeake Bay and perhaps was also due to a change in the food chain (plankton, etc.) caused by the hurricane.

Although the Gulf menhaden were smaller than the Atlantic menhaden sampled, they had a significantly higher oil content. The proximate analyses fell within the ranges reported by Thompson (1966) for Gulf menhaden caught by trawlers of the industrial (pet food) fishing fleet. Thompson did not find a reliable correlation between menhaden size and oil content for the gulf species.

Fish Protein Concentrate

Table 3 shows the proximate composition and protein efficiency ratio (PER) for FPC's made from whole menhaden sampled during the 1972 fishing season. Most of the FPC's produced were either borderline or deficient in terms of the FDA specification of 75 percent minimum protein for fish protein concentrate. Mean protein content for both the Atlantic and Gulf menhaden FPC samples was slightly below the 75 percent specification. This was due primarily to the high bone content of menhaden and for this reason wet deboning machines were included in the process line at the FPC Experiment and Demonstration Plant (Ernst, 1971). For these limited data the correlation between FPC protein and menhaden ash content was not very good ($r = -0.603$). The FPC samples, with an average oil content of about 0.1 percent were considerably below the FDA specification for a maximum of 0.5 percent residual lipids.

Protein Quality

The protein quality of menhaden FPC's as measured by PER did not reveal any particular seasonal trend. In general the PER's were practically

Table 3.—Proximate composition and protein efficiency ratio of menhaden FPC produced from whole fish during fishing season of 1972.

Source and Date	Crude Protein (%)	Residual lipid (%)	Volatiles (%)	Ash (%)	PER	PER relative to casein (%)
B. tyrannus (Chesapeake Bay)						
6/15	74.70	0.12	9.31	18.64	3.53	101
6/27	78.95	0.09	6.90	17.18	3.56	101
7/25	76.12	0.08	7.94	18.67	3.69	103
8/30	70.87	0.07	8.52	23.87	3.53	101
9/19	74.65	0.11	4.83	22.91	n.a.	n.a.
10/6	69.82	0.05	8.40	23.99	3.34	97
10/27	74.31	0.10	8.53	19.70	3.57	103
11/17	73.06	0.02	8.09	20.98	3.69	107
	$\bar{x}$ = 74.06	0.08	7.82	20.74	3.56	101.86
B. patronus (Gulf of Mexico)						
5/26	75.68	0.53	7.34	19.45	3.37	97
7/27	74.04	0.03	7.17	21.44	3.70	105
9/12	73.54	0.03	9.87	20.40	3.63	104
10/10	72.40	0.05	8.72	21.61	3.77	110
11/8	75.17	0.17	8.06	20.13	3.57	103
12/3	75.06	0.02	7.79	18.33	3.43	99
	$\bar{x}$ = 74.31	0.14	8.16	20.23	3.62	103.00

Table 4.—Fatty acid compositions[1] of extracted menhaden oil, 1972 season.

Fatty acids	Atlantic menhaden							Gulf menhaden		
	6/15	6/27	7/25	8/30	9/19	10/6	11/17	9/12	10/10	12/3
Saturated										
14:0	7.00	9.93	7.98	7.02	8.45	8.47	9.73	8.63	6.92	7.92
15:0	0.61	0.79	0.73	0.96	1.18	1.23	1.29	0.68	1.18	0.92
16:0	11.86	12.35	10.73	18.31	14.60	19.45	27.03	11.69	10.20	17.53
17:0	1.35	1.17	1.25	1.98	1.46	2.50	2.00	1.35	1.81	1.26
18:0	3.23	2.93	2.28	5.24	3.34	5.61	6.62	3.41	3.77	5.40
20:0	0.50	0.47	0.44	1.92	0.48	2.29	—	1.46	2.36	—
Total:	24.55	27.64	23.41	35.43	29.51	39.55	46.67	27.22	26.24	33.03
Monounsaturated										
14:1	0.35	0.47	0.40	0.49	0.68	0.70	0.43	0.22	0.29	0.23
15:1	0.16	0.19	0.18	0.26	0.26	0.28	0.19	0.10	0.12	0.13
16:1	9.41	11.19	9.46	9.74	10.63	9.88	8.37	11.41	9.51	10.68
17:1	1.66	1.93	1.88	0.54	1.59	0.57	1.05	0.36	0.35	—
18:1	10.36	9.23	9.15	7.92	5.54	7.10	6.97	8.10	6.34	8.67
20:1	1.90	1.83	2.31	1.47	0.63	1.13	1.31	1.89	1.15	1.87
Total:	23.84	24.84	23.38	20.42	19.33	19.66	18.32	22.08	17.76	21.58
Polyunsaturated										
18:2ω9	1.78	1.63	1.99	1.55	1.74	1.73	0.55	1.45	1.98	0.88
18:2ω6	1.84	1.59	1.77	0.49	0.45	0.40	1.20	0.59	0.70	1.59
18:4ω3	3.40	3.53	4.05	2.11	3.86	2.71	1.99	1.91	2.31	2.23
20:2ω9	0.52	0.39	0.38	0.47	0.60	0.37	—	0.60	0.49	0.27
20:3ω9	0.30	0.28	0.24	0.56	0.30	0.32	0.19	—	—	0.23
20:4ω6	1.28	1.07	1.13	1.48	1.35	1.17	1.18	2.51	2.48	1.92
20:4ω3	2.32	2.05	2.34	1.83	1.77	1.61	1.08	1.80	1.83	1.51
20:5ω3	13.70	12.50	15.24	9.13	10.70	7.21	7.63	15.12	12.96	13.40
22:4ω6	1.22	1.07	1.04	0.94	1.17	1.19	1.05	1.83	1.85	1.46
22:5ω6	1.18	0.92	0.82	1.86	0.71	2.11	1.33	1.54	2.38	1.24
22:5ω3	3.16	2.60	2.86	2.89	2.23	2.28	1.57	5.09	3.95	3.51
22:6ω3	14.49	12.99	17.46	14.17	18.75	13.17	15.22	11.00	16.39	13.48
Total:	45.19	40.62	49.32	37.48	43.63	34.27	32.99	43.44	47.32	41.72

[1]As percent of total fatty acids measured.

Table 5.—Summary of fatty acid compositions[1] by degree of unsaturation, 1972 season.

	Atlantic menhaden							Gulf menhaden		
	6/15	6/27	7/25	8/30	9/19	10/6	11/17	9/12	10/10	12/3
Saturated fatty acids	24.55	27.64	23.41	35.43	29.51	39.55	46.67	27.22	26.24	33.03
Monounsaturated	23.84	24.84	23.38	20.42	19.33	20.65	18.32	22.08	18.64	21.58
Polyunsaturated	45.19	40.62	49.32	37.48	43.63	34.27	32.99	43.44	47.32	41.72
Unidentified	6.42	6.90	3.89	6.67	7.53	5.53	2.02	7.26	7.80	3.67
Total U/S	2.81	2.37	3.11	1.63	2.13	1.39	1.10	2.41	2.51	1.92
Total percent oil	12.77	17.90	10.60	10.64	4.34	4.01	4.36	23.90	12.29	10.58

[1]As percent of total fatty acids measured.

equal to or slightly higher than the reference casein values. The PER's for Atlantic menhaden FPC ranged between 97 and 107 percent, averaging 102 percent, relative to the casein PER value. The Gulf menhaden PER's averaged 103 percent relative to casein and ranged between 97 and 110 percent.

Fatty Acids

The fatty acid patterns of Atlantic and Gulf menhaden, as measured by GLC analysis of the extracted fish oils, are presented in Table 4. Duplicate analyses of each sample were made. These data are grouped on the basis of degree of unsaturation and are summarized in Table 5. For the Atlantic menhaden there was an irregular trend toward more saturated fatty acids during the course of the fishing season and the ratio of unsaturated to saturated fatty acids (U/S ratio) decreased from 2.81 in June to 1.10 in November. Analyses are available on only three Gulf menhaden samples, but the saturated fatty acid content was higher in the December sample relative to the earlier samples.

Data reported by Gruger, Nelson, and Stansby (1964) for an Atlantic menhaden sample taken in December 1959 had 43.3 percent saturated fatty acids and a relatively low U/S ratio of 1.305. The palmitic acid content of the sample was particularly high at 28.9 percent. The later (Aug.-Nov.) 1972 samples of Atlantic menhaden had higher palmitic acid levels than earlier (June-July) samples and the November value reached 27 percent. The November Gulf sample contained only 17.5 percent palmitic acid but was notably higher than the earlier Gulf samples. All of the Atlantic and Gulf samples had a higher palmitoleic content and a lower oleic acid content relative to the data of Gruger et al. (1964) which were 7.9 percent and 13.4 percent, respectively, for the 16:1 and 18:1 fatty acids. The other fatty acids reported generally fell within the same range as our 1972 data. By family groupings, the polyunsaturates within the 1972 data were slightly higher in ω6 fatty acid content, slightly lower in ω9 content, and similar in ω3 content in comparison with the data of Gruger et al. (1964).

Erucic acid (22:1ω9) was measured in only two samples, 0.99 percent in the

10/6 Atlantic menhaden and 0.88 percent in the 10/10 Gulf menhaden. It appeared as a shoulder to the adjacent peak of 20:4ω6 combined with 20:3ω3. Probably erucic acid was present in other samples but was masked by the adjacent fatty acid peak.

SUMMARY AND CONCLUSIONS

Some seasonal data on the proximate composition of Atlantic menhaden (*B. tyrannus*) sampled over the 1967-69 fishing seasons are presented and show a peak in oil content during the month of October. Chemical composition and length-weight data are also presented for samples of Atlantic and Gulf menhaden collected during the 1972 season. The Atlantic menhaden had an abnormal pattern of oil content and size, possibly due to environmental changes caused by Hurricane Agnes which struck the Atlantic coast in June of 1972.

Fish protein concentrates were prepared by isopropanol extraction of the 1972 samples and were evaluated by rat bioassay. No seasonal trends in menhaden protein quality were detected and the PERs averaged slightly higher than those of the reference casein.

The fatty acid patterns of the extracted menhaden oils were analyzed by GLC. There was an apparent trend toward a higher proportion of saturated fatty acids, particularly palmitic acid, as the season progressed from June to December. A comparison between 1972 Atlantic and Gulf samples and an additional Atlantic menhaden analysis from the literature indicates that the observed trend is truly seasonal rather than being directly related to the abnormal pattern of oil content in 1972 samples from the Chesapeake Bay area. Additional data from other years would be required to confirm the trend, however.

There is a need for updating composition data on both the menhaden resource and the fish meal, oil, and solubles products of industry. Industrial practice has changed somewhat in recent years with a greater proportion of "whole" fish meals containing added solubles being produced. The acquisition of appropriate data and the determination of new menhaden products of higher value have been proposed as goals of the NMFS.

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MFR PAPER 1200

The Giant Pacific Octopus

WILLIAM L. HIGH

ABSTRACT—Octopus dofleini *is the largest of several octopus species inhabiting coastal waters from California northward to Alaska and across to Japan. It lives in caves and discarded man-made items from the intertidal zone to depths greater than 100 fathoms. Growth appears to be rapid, with individuals reaching weights greater than 100 pounds within about 5 years. Food for the creature includes crabs, clams, and fish. Adults commonly die after breeding activities. Information on its behavior has been increased through the use of scuba diving equipment. Divers routinely handle or capture large specimens without exceptional risk; however, several divers have been bitten. This naturally timid creature has sometimes attacked underwater swimmers, but usually incidents occur only after the animal is seized. There are limited commercial octopus fisheries for both halibut bait and human food. North American landings by all fishing methods are small.*

INTRODUCTION

Of all the creatures in the sea, the giant Pacific octopus, *Octopus dofleini*, is perhaps the most reviled and misunderstood. The French author Victor Hugo created a reputation for it that makes people shudder. Hugo condemned the octopus with his description of an eight-armed creature battling a man to the death, while in reality the octopus deserves recognition as an interesting and useful sea animal.

Little was known about the life and habits of the octopus until scuba apparatus permitted man to descend into Neptune's realm. Recreational divers in Washington and British Columbia recognized the public attention potential associated with this undersea creature and by 1956, hundreds of divers gathered at Puget Sound, Wash., to compete for the Octopus Wrestling Championship of the World. Soon, divers collectively possessed a far greater understanding of this fascinating and intelligent creature than did the scientific community. Unfortunately, no coordinated effort was made to record the divers' extensive naturalist-type observations. By 1965, most divers sought other undersea adventures, thus leaving studies of the octopus to a few students of its behavior.

High

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DISTRIBUTION

Octopuses are found throughout the world but the giant octopus occurs only along the Pacific rim of North America from California northward through British Columbia and Alaska, and across to Japan (Pickford, 1964). Its center of abundance appears to be Puget Sound in Washington State and British Columbia (High, 1960). Prior to the advent of scuba diving, giant octopuses were occasionally encountered in west coast waters by beachcombers searching among rock crevasses and caves at low tide and by line fishers who accidently hooked them. Incidental catches (in trawl nets set at depths to 100 fathoms or more) found a limited market, as did catches made using small trap-like enclosures sought out by the animals as protective dens.

Seclusion and protection seem to be the major criteria for an octopus den. In addition to natural caves and holes dug beneath rock formations (Fig. 1), individuals are often found in the debris of civilization, particularly barrels, jugs, cans, tires, and bottles which lie on the ocean floor. Small octopuses are commonly found inside beer bottles. Like their mechanical counterparts in the movies, octopuses commonly inhabit sunken ship hulls (Fig. 2).

The opening into the den of even a large octopus may be only a few inches high. Since the animal has no bones, it can squeeze into almost any shape to permit passage through small openings (Voss and Sisson, 1971). One specimen weighing over 100 pounds escaped from a cage having a maximum opening of just over two square inches. Often the cave of an octopus has a secondary opening to allow a strategic withdrawal from an attacking predator.

FAST GROWTH—SHORT LIFE

Observations conducted both in the natural environment and aquaria have recently added large pieces to the octopus life history puzzle. Those captured at the World Octopus Wrestling Championship (Fig. 3) fit into what might be well-defined age groups (High, 1963).

Several octopuses in excess of 100 pounds have been encountered and captured. Much larger ones have been

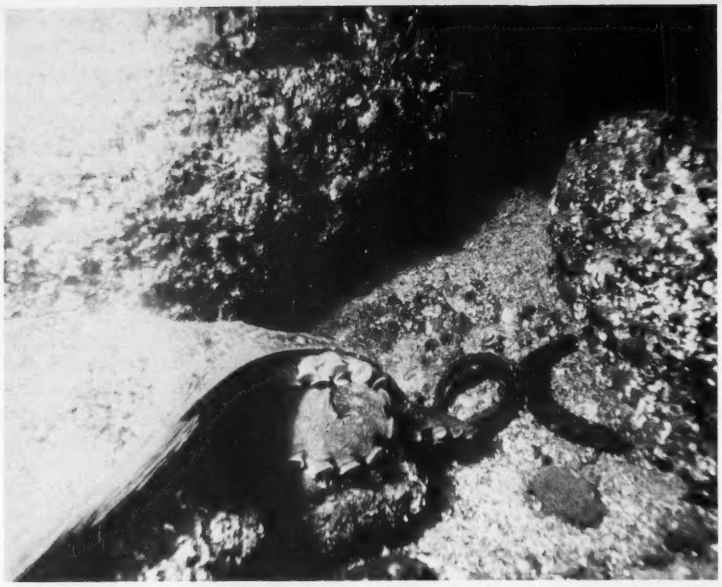

Figure 1.—A well camouflaged octopus begins to emerge from a large den scoured out beneath a 10-foot diameter rock. Several 6- to 10-inch high openings were located around the rock base.

reported but, like the Loch Ness Monster, these usually elude the careful photographer or scientist. Most octopuses weigh less than 70 pounds with a stretched length of 15 feet or less. Overall length between arms is not a suitable measure because of the animal's unusual elasticity.

In the late 1950's, I interviewed a Canadian commercial diver, Jock MacLean of Prince Rupert, B.C. He reported capturing an immense creature weighing 600 pounds and measuring 32 feet from arm tip to top. MacLean's photographs, unfortunately, were of poor quality. Smaller animals, to 400 pounds, were occasionally taken in his commercial octopus fishing endeavor.

Life expectancy appears to be about 4½ to 5 years with both male and female commonly dying after breeding. Breeding males in aquaria die within 3 months, whereas females brood the eggs for several months until hatching, then die within 2 months (Eilene Solie, Univ. Puget Sound, Tacoma, WA 98416, pers. commun.).

Bruce Edney, an engineer with the Honeywell Corporation, spent 9 months of his leisure time observing and photographing the egg brooding process conducted by a female octopus. In that period, he made 39 day or night scuba dives to the cave site. Thousands of rice-shaped eggs hung in strings from the cave roof around the parent (Fig. 4). The eggs appeared to be newly laid in May when the cave was discovered. The female octopus was present at each visit and did not depart in November when the eggs hatched. The adult's appearance deteriorated near hatching time when the normal red color changed to pale gray. In January, the animal was found dead in the cave.

Several hundred eggs were removed when hatching time appeared near, and they were incubated in an aquarium. After the eggs hatched, the fully formed octopuses were returned to the cave. As those hatched in the aquarium were released in the cave, they immediately began swimming up toward the surface (Bruce Edney, pers. commun.).

MOVEMENTS AND FEEDING

The octopus is highly mobile. It crawls lightly along the bottom using its arms or swims off-bottom utilizing a form of jet propulsion (Fig. 5). Water drawn into the body cavity through the mantle opening during the breathing process can be expelled forcefully through the siphon, resulting in considerable thrust. A diver must swim rapidly to keep up with a jetting 50-pound animal.

Food for the octopus consists of crabs, clams, and fish—all of which can be captured alive. Octopuses have been observed both in aquaria and in nature to catch several crabs and then hold them with the suction discs until ready to eat. Thus, an octopus could theoretically obtain food for several days at one time and hold it captive until hungry. Clams are dug using a power water jet from the siphon, which can blast away sand and mud. I saw portions of freshly killed rockfish, *Sebastes* sp., twice in octopus caves, confirming their use as a food source. However, rockfish are commonly observed swimming in an undisturbed manner within an occupied den.

Food is carried to the den, permitting the octopus to feed leisurely in safety. Remains, such as shells and bones, are discarded outside the den creating readily detectable refuse piles (High, 1960).

AGGRESSIVE BEHAVIOR EXAGGERATED

The great octopus is by nature a timid animal, generally found hiding deep within its lair or carefully camoflaged against a rock or among kelp fronds. As with most general rules, there are numerous exciting exceptions. On at least two occasions scuba divers were ambushed by large octopuses lying on ledges above the passing swimmers. The creatures descended unnoticed and landed squarely on the divers' backs. In each case it required several seconds for both the frightened diver and his buddy to pull the eight-armed creature free. These might be recorded as unprovoked attacks. It is unlikely the creature considered the divers as anything more than potential meals.

Aggressive behavior is usually observed only when the animals are molested (Fig. 6). Once I was confronted by a 75-pound male when I placed my head into a large cave. The octopus repeatedly drove me away by rushing to the cave entrance. After it was removed by our diving party, a second, larger octopus emerged. Seldom are two octopuses found sharing a single

cave. Perhaps this was a mating pair and the male was defending its territory.

On another occasion an octopus estimated to weigh well over 100 pounds was encountered adjacent to a rock. A speargun carried by the diver was used as a prod to cause the animal to spread out for improved viewing. Instantly, this behemoth seized the gun and bit the heavy propulsion rubber in half with its beak. Discretion prompted the diver to vacate the area.

Divers seldom report being bitten while handling these animals. However, Snow (1970) documented two incidents when divers, deliberately handling octopuses underwater, were bitten. Also, the author observed two divers being bitten while a group of divers were engaged in capturing several animals. During all four incidents the victims were: wearing diver wet suits, were "attacking" the animals, and all were bitten on the hand or wrist. The divers' skin was not exposed to the bite site since it is standard practice for local divers to wear gloves of wet suit neoprene. Although bleeding was usually profuse and healing prolonged, no special treatment was required.

Tales of octopuses sucking human blood are contrary to fact. However, the vacuum caused by suction discs can draw blood to the skin's surface. The resulting welt will remain for several hours. Fortunately, the divers' neoprene exposure suit protected nearly all skin from the effect of a secure grip.

HANDLING UNDERWATER

Scuba divers seek out octopuses for both adventure and study. It is a considerable challenge to entice an animal out of its lair. Food placed near the entrance to a den often causes a long arm to appear. Food also causes the octopus to modify its usually timid behavior. Two octopuses observed astride pots containing live Dungeness crabs, *Cancer magister*, were defensive and ignored advances made by divers (High, 1976). The divers touched, pushed, and finally slapped the octopuses as they reached inside the pot for crabs. After being forcibly removed and carried about 15 feet away from the crab pots, one animal returned, crawled between the pot and diver,

Figure 2.—A diver is shown reaching for the suction disc lined arm of a giant octopus beneath the boiler of a sunken ship. Note that two crab carapaces and several clam shells lie adjacent to the den entrance.

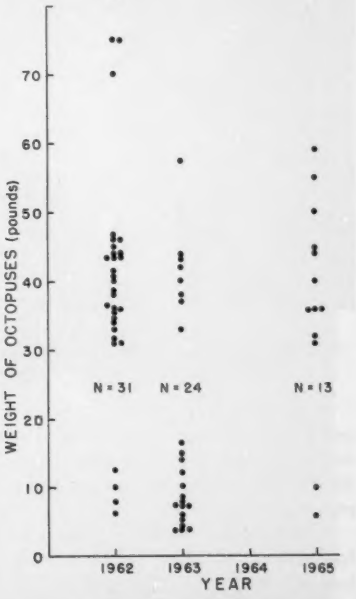

Figure 3.—Weight of octopuses captured by divers during three World Octopus Wrestling Championships held in April at Titlow Beach, Puget Sound, Wash. The 13 octopuses shown for 1965 only represent animals taken by the three top diver teams.

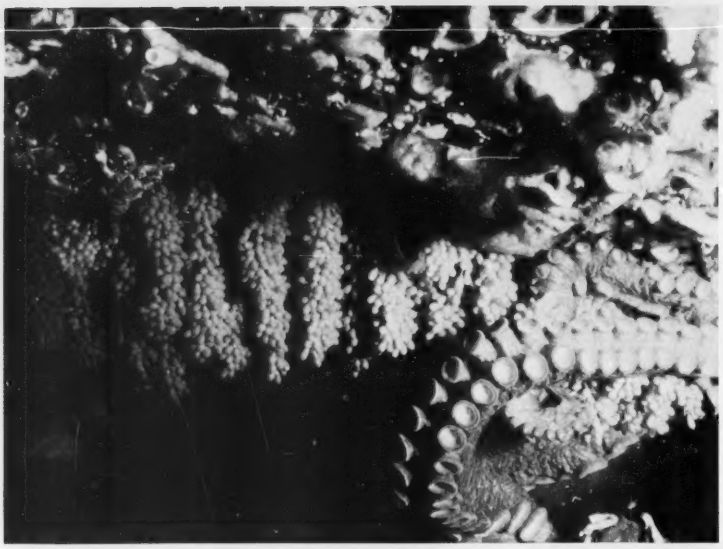

Figure 4.—Strings of eggs attached to a den's ceiling are watched over by a female octopus. Water expelled through the syphon (swimming funnel) aerates and cleans the egg clusters. Photo courtesy of Hydro Photo—Lee Grobe.

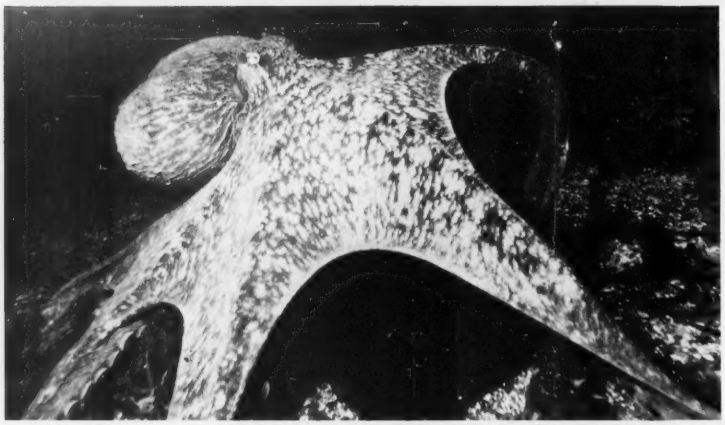

Figure 5.—An octopus weighing about 35 pounds moves across the sea floor supported on its arm tips.

and proceeded to probe for crabs. The defiant octopus left only after being displaced a second time and offered a crab from the pot.

To bring these creatures to the surface, the diver must secure a good hold, generally with both hands on the mantle or around the body, and wrench it free of the bottom. It is often necessary to pull the eight arms, one at a time, from the rocks surrounding the den. A rule of honor among sport divers is that no action be taken against the octopus that will cause injury. Washington State regulations prohibit use of knives, spears, or other instruments to puncture the skin.

This animal is unpredictable. It may be docile as it is pulled to the surface or it may grasp the diver with one or all eight arms. These naturally timid creatures have pinned divers' legs together, pulled off their face masks, and torn out scuba mouthpieces. Using all their arms they will try many tricks to free themselves and oftentimes the diver is only too glad to let go and get free from this overpowering giant (High, 1971).

In the event the ocean bottom is composed of small loose rocks, the octopus may cling to more than 50 pounds of rocks and the diver too (Fig. 7). When this occurs, the diver must free himself by letting go of the creature. Fortunately, when the diver releases his hold, the octopus will usually do likewise within a few seconds.

Contrary to many popular stories, the octopus does not generally use its ink as a direct form of defense. When a scuba diver manhandles an octopus, it fights with its arms. Once set free, however, it will straighten out, jet away, and leave an ink cloud behind. This is apparently intended to act as a decoy, creating the illusion that the creature is still there while in fact it is seeking the bottom and safety in a cave.

OCTOPUS FISHERY

A personal-use fishery for octopuses has existed for many years near population centers in Puget Sound, Wash.; British Columbia; and southeastern Alaska. In past years octopuses were taken by hand or gaff from the intertidal zone. These were marketed, primarily in Oriental communities. A cloth bag containing copper sulphate crystals was tied to a stick and then thrust into a cave suspected of harboring an octopus. The dissolving chemical contaminated the water, forcing the creature into view, and then it was gaffed. Both the gaff and chemical are now illegal devices in Washington. A limited market exists for octopuses captured incidentally in otter trawl fisheries.

Following World War II, numerous fishers attempted pot fishing for octopuses in Puget Sound. Others investigated the fishery potential in British Columbia, southeastern Alaska, and the Kodiak Island region because of the great demand for the octopus as halibut bait during the late 1950's and 1960's. Small-scale fisheries attempted by scuba divers were generally short-lived. Divers now may not capture octopuses commercially in Washington.

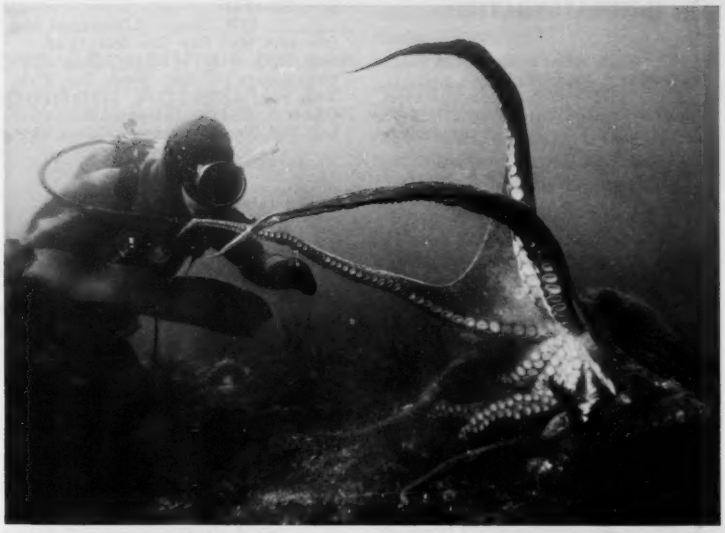

Figure 6.—An octopus encountered by a diver in the open assumes an uncommon defensive position. In reality, the creature is only a minor threat to an experienced diver.

Fishing devices such as grapples, baited jigs, and lures which are commonly used in Japan (Mottet, 1975) are not likely to be acceptable or successful along the North American coast because of their possible conflict with existing commercial and recreational water use and because they yield a relatively low financial return.

Part-time fisher Ben Frick, fishing octopus pots near Dungeness Spit in Puget Sound, was one of the few successful pot fishers. He tended strings of pots from the late 1950's until his death in 1973. In that year, two other fishers fished octopus pots in Puget Sound, one near Tacoma and the other in Hood Canal. The number of bottomfish trapping licenses issued in Washington, which also permit the taking of octopuses, increased from 1 in 1969 to 15 in 1974. The increase primarily reflects interest in trapping finfish rather than octopuses.

Landings for the octopus in Oregon ranged from 1,000 to 11,000 pounds from 1969 through 1973. Alaska landing statistics do not identify any octopus landings. Since 1965, landings in Washington have varied between 24,000 and 41,000 pounds, most of which were taken by otter trawl. It is not likely that commercial landings will greatly increase in the near future, unless there is an increase in demand for octopuses. And the question remains whether a substantial increase in the harvest could be sustained because little is known about the size of inshore and offshore populations of this interesting animal.

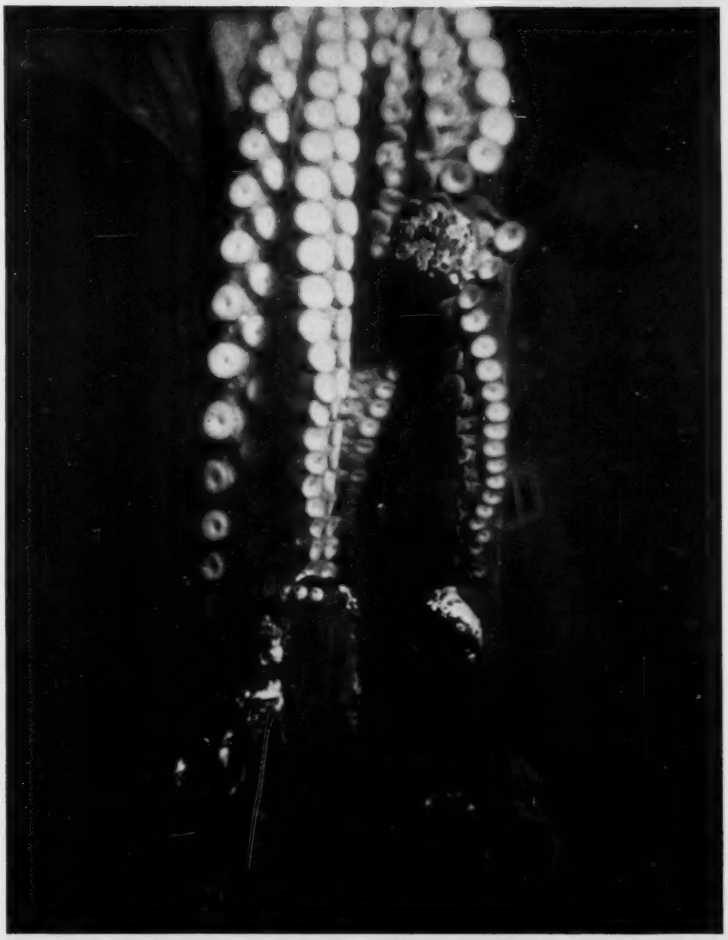

Figure 7.—Several rocks hang from the arms of an octopus lifted from the sea floor by a nearly hidden diver. Occasionally the creature may cling to 50 pounds of rocks or more, making it difficult for a diver to surface with the animal.

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MFR Paper 1200. From Marine Fisheries Review, *Vol. 38, No. 9, September 1976. Copies of this paper, in limited numbers, are available from D825, Technical Information Division, Environmental Science Information Center, NOAA, Washington, DC 20235. Copies of* Marine Fisheries Review *are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 for $1.10 each.*

NOAA Answers Questions About the Fishery Conservation and Management Act of 1976

The Fishery Conservation and Management Act of 1976 creates a 200-mile fisheries zone off the coasts of the United States, and establishes several new mechanisms for enforcement. Many questions have arisen about the working of the new law and what it will mean to fishers, to processors, and to others involved in the nation's fisheries. The National Oceanic and Atmospheric Administration has prepared the following answers to some of the most-asked questions, and the U.S. Coast Guard has provided additional information to give further information on their plans under the law.

FISHERY MANAGEMENT AUTHORITY

Q. What is the "fishery conservation zone" that is established by the Act?

A. The U.S. fishery conservation zone adjoins the territorial sea (the 3-mile limit); its outer boundary is 200 nautical miles from the coast.

Q. What fisheries are affected?

A. The United States will exercise exclusive fishery management authority over: 1) All fish found within the fishery conservation zone except tuna; 2) All anadromous species that spawn in U.S. waters, throughout their migratory range beyond the zone, except during the time they are in another nation's territorial sea or fishery conservation zone that the U.S. recognizes; 3) All U.S. continental shelf fishery resources that extend beyond the zone, such as coral, crab and lobster, clams and abalone, and sponges.

Q. What fisheries are not affected?

A. Highly migratory species of fish, defined in the Act as tuna.

Q. When does the exclusive authority take effect?

A. March 1, 1977.

Q. Why so long?

A. To permit renegotiation of fisheries agreements with other nations and establishment of Regional Fishery Management Councils.

FOREIGN FISHING AND INTERNATIONAL FISHERY AGREEMENTS

Q. Once the law takes effect, will foreign fishing be permitted in the 200-mile zone?

A. Yes, but only under the following conditions: 1) If a treaty of international fishery agreement already exists, foreign fishing will be permitted until the treaty or agreement expires or is renegotiated, and each foreign vessel must have a registration permit issued by the Secretary of State; 2) Otherwise the foreign vessel must have a permit issued by the Secretary of Commerce through the Secretary of State.

Q. How does the Secretary of Commerce issue permits to foreign fishing vessels?

A. The Act gives detailed account of this procedure. In brief, this is what must happen: 1) A foreign nation must first enter into what is called a Governing International Fishery Agreement (GIFA) with the United States; 2) Under such an agreement, the foreign nation must apply each year for permits for all of its fishing vessels that wish to fish for species covered by the Act within the zone; 3) When the Secretary of State is satisfied that the permit application complies with the requirements of the Act, he will send it to the Secretary of Commerce, the Secretary of Transportation, the appropriate Regional Fishery Management Council and designated committees of Congress; 4) The applicable Regional Fishery Management Council has 45 days to comment on the application; 5) After taking such views into consideration, and after payment of fees, the Secretary of Commerce may then approve the application.

Q. Will there be a fee for foreign fishing vessels?

A. A "reasonable" fee may be charged; such fees must apply without discrimination to all foreign nations, and their costs may take into account the cost of management, research, administration, enforcement, and other items.

Q. How much fish will foreign vessels be permitted to take?

A. Only that portion of the optimum yield of a fishery, if any, that will not be harvested by U.S. fishermen.

Q. What is "optimum yield"?

A. Optimum yield is defined as that part of a fishery that will provide "the greatest overall benefit to the Nation, with particular reference to food production and recreational opportunities . . ." In other words, a variety of economic, social, and ecological factors are taken into account as well as biological factors.

Q. Who determines optimum yield?

A. The optimum yield for each species will be specified in a fishery management plan drawn up by the Regional Fishery Management Council in whose area the species is found.

Q. How will enforcement officers of the National Marine Fisheries Service and the Coast Guard know whether a particular foreign vessel has a valid permit?

A. Every foreign fishing vessel must display the permit prominently in its wheelhouse; the permit will contain a statement of all the conditions and restrictions attached to it.

Q. What happens to violators?

A. Tough civil and criminal penalties are provided in the Act. In addition, if the fines are not paid, the permit for the vessel, or for all vessels of the nation, may be suspended.

REGIONAL FISHERY MANAGEMENT COUNCILS

Q. What are Regional Fishery Management Councils?

A. Regional Fishery Management Councils are the basic tool for management and conservation of America's fisheries within the 200-mile zone and otherwise as specified by the Act.

Q. What do they do?

A. Duties and responsibilities of each Council are: 1) To develop fishery management plans and amendments to them; 2) To submit periodic reports to the Secretary of Commerce; 3) To review and revise assessments of optimum yield and allowable foreign fishing; 4) To conduct public hearings on development of fishery management plans and on the administration of the Act; 5) To establish scientific and sta-

tistical committees and necessary advisory panels; 6) To undertake any other activities necessary to carry out the provisions of the Act.

Q. What Councils are called for in the Act?

A. There are eight, as follows: 1) New England Council, consisting of the States of Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut; with 17 voting members. 2) Mid-Atlantic Council, consisting of the States of New York, New Jersey, Delaware, Pennsylvania, Maryland, and Virginia; with 19 voting members. 3) South Atlantic Council, consisting of the States of North Carolina, South Carolina, Georgia, and Florida; with 13 voting members. 4) Caribbean Council, consisting of the Virgin Islands and Puerto Rico, and 7 voting members. 5) Gulf Council, consisting of the States of Texas, Louisiana, Mississippi, Alabama, and Florida; with 17 voting members. 6) Pacific Council, consisting of the States of California, Oregon, Washington, and Idaho; with 13 voting members. Idaho is included because Pacific salmon migrate up the Columbia River and its tributaries into Idaho, where major spawning areas are located. 7) North Pacific Council, consisting of the States of Alaska, Washington, and Oregon; with 11 voting members. 8) Western Pacific Council, consisting of the State of Hawaii, American Samoa, and Guam; with 11 voting members.

Three States—Florida, Washington, and Oregon—have voting members on more than one Regional Council.

Q. Who are voting members of the Councils?

A. Voting members are: 1) The principal state official with marine fishery management responsibility and expertise, as designated by the state governor; 2) The regional director of the National Marine Fisheries Service for the area concerned; 3) At least one "qualified individual" from each state, selected by the Secretary of Commerce from nominations by the state governors; 4) Additional "qualified individuals" who will be appointed at large; the number of these varies with the number of states in the Regions. They too will be appointed by the Secretary of Commerce from nominations by the state governors.

Q. Who are "qualified individuals"?

A. Qualified individuals are those who are "knowledgeable or experienced with regard to the management, conservation, or recreational or commercial harvest, of the fishery resources of the geographical area concerned."

Q. Who are non-voting members of the Councils?

A. Non-voting members are: 1) The regional or area director of the U.S. Fish and Wildlife Service; 2) The Commander of the Coast Guard District; 3) The executive director, if any, of the appropriate Marine Fisheries Commission; 4) One representative of the Department of State.

In addition, the Pacific Council has one non-voting member appointed by the Governor of Alaska.

Q. Where will the Councils be located?

A. Each Council will decide that for itself, in accordance with uniform standards provided by the Secretary of Commerce.

Q. How will the Councils operate?

A. Each Council will be free as it sees fit, in accordance with uniform standards prescribed by the Secretary of Commerce. NOAA is now drafting such standards.

Q. Then, once established, the Councils are quite independent?

A. True. They are not arms of the Federal or of any State Government.

Q. How will Council members be paid?

A. Each non-government voting member will be paid on a per diem basis, that is, for the days actually worked on the Councils. The rate is approximately $150/day. In addition, all voting and non-voting members will be reimbursed for actual expenses, such as travel, connected with Council operations.

FISHERY MANAGEMENT PLANS

Q. I have heard about "preliminary fishery management plans" and "fishery management plans." What's the difference?

A. A "fishery management plan" is a plan prepared by a Regional Council, designed to provide conservation and management of a particular species of fish found within the geographical area of the Council. A "preliminary fishery management plan" is a plan prepared by the Secretary of Commerce. Such plans will be prepared only in cases where a foreign nation has applied for a fishing permit and the Regional Council cannot prepare its plan by the deadline (1 March 1977).

Q. Will preliminary fishery management plans apply to U.S. fishers?

A. No. Only to foreign fishers.

Q. How long will a preliminary plan be in effect?

A. Only until a plan prepared by a Regional Council is implemented.

Q. What, if any, guidance will there be for the Councils in drawing up the plans?

A. The Act establishes seven "national standards" that every plan must be consistent with, as well as requirements for contents of every plan. The Secretary of Commerce will also provide guidelines based on the national standards.

Q. What are the national standards?

A. They are: 1) Conservation and management measures shall prevent overfishing but achieve optimum yield from each fishery; 2) These measures shall be based on the best scientific information available; 3) To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range; 4) Conservation and management measures shall not discriminate between residents of different states; 5) The measures shall, where practicable, promote efficiency in the use of fishery resources; 6) They shall take into account and allow for variations among fisheries, fishery resources and catches; 7) And, where practicable, they shall minimize costs and avoid unnecessary duplication.

Q. What are fishery management plans required to contain?

A. Each such plan must contain: 1) Conservation and management measures applicable both to foreign and U.S. fishing; 2) A description of the fishery, including such information as the number of vessels involved, type and quantity of gear used, revenues, recreational interests, and other specified items; 3) An assessment of present and probably future condition of the fishery, including both maximum sustainable yield and optimum yield; 4) An assessment of the extent to which U.S.

fishers will harvest the optimum yield, and of the portion of the optimum yield that can be made available to foreign fishers.

Q. Anything else?

A. In addition to the required items, there are a great many optional items, such as: 1) Requirements for permits and fees that the Secretary of Commerce should levy on U.S. fishers; 2) Designation of zones and periods of time when fishing should be limited, or banned; 3) Establishment of limits on the catch, based on area, size, weight, or other factors; 4) Establishment of a system of limited access.

Q. Do the Councils have any regulatory authority with respect to the Fishery Management Plans?

A. The Councils may prepare and submit to the Secretary of Commerce any proposed regulations that they feel are necessary to carry out any fishery management plan.

Q. How high can the domestic permit fees be?

A. These fees are not to exceed the administrative costs of issuing permits.

Q. What happens to a fishery management plan once it has been prepared by a Regional Council?

A. The plan is submitted to the Secretary of Commerce. He has 60 days to review it and notify the Council of his approval, disapproval, or partial disapproval. If he disapproves in whole or in part, he has to give the reasons why, in detail, with suggestions for improvement.

Q. If the Secretary approves, what happens?

A. He publishes it in the Federal Register. After hearings, objections, and other administrative actions, the plan is put into effect.

Q. Suppose the Secretary disapproves and tells the Council why?

A. The ball is back in the Council's court, to come up with changes to meet his objections.

Q. Suppose the Secretary and the Council can't come to agreement?

A. The Secretary can then put into effect his own plan. However, he cannot establish any kind of limited entry system unless it is approved by a majority of voting members of the pertinent Council.

U.S. COAST GUARD ROLE

The new law creating a 200-mile fisheries zone means the U.S. Coast Guard and National Marine Fisheries Service will have—potentially, at least—about 2 million square miles of ocean to patrol starting next March. Immediate plans call for reactivation of three old Coast Guard cutters and retention on active duty of a fourth, even though it had been scheduled to be decommissioned. To meet interim aircraft requirements, the Coast Guard is reactivating four retired Defense Department planes and is placing its last five spare short-range helicopters into service.

Coast Guard enforcement of the new law will involve two complementary concepts: Primary patrol operations in active fishing areas and less frequent random patrols to the limits of U.S. fisheries jurisdiction. Much of this area already is patrolled by the Coast Guard to protect creatures of the continental shelf. Expansion of Coast Guard activities in this area could be influenced by the extent of cooperation of other nations.

Coast Guard cutters to be placed back into service are: *Spencer*, 327 feet long, built in 1937, World War II veteran credited with sinking two German U-boats, also used widely in Pacific landings; *Unimak*, 311 feet long, built in 1942 as a Navy seaplane tender; *Sorrel*, 180-foot buoy tender, built in 1943. The cutter *Gentian*, another 180-foot buoy tender, built in 1942, currently stationed at Galveston, Tex., is to be retained in commission.

France, U.S. Announce Joint Oceans Program

New programs to develop methods of protecting the ocean and its resources, and to understand its processes, were announced jointly by the United States and France earlier this year. Robert M. White, Administrator of the National Oceanic and Atmospheric Administration, for the United States, and Yves LaPrairie, President and Director-General of France's National Center for the Exploitation of the Oceans, outlined the plans on 12 May. The announcement concluded a 3-day meeting of the U.S.-French Cooperative Program in Oceanography, held in New Orleans. The collaboration has been underway since 1970.

The two leaders said that nation-to-nation cooperation in ocean affairs, always important, has become more vital than ever as world interest in protecting the oceans increases and as needs for ocean resources become more acute. Ocean problems are of increasing public concern, they said: "We meet against this background of concern. The past year has brought greatly intensified interest in the oceans. We feel fortunate that the U.S.-French program is in being, and producing constructive action."

New areas in which the U.S. and France will cooperate, and areas being examined for future cooperation, are: 1) The exchange of plans and proposals for undersea scientific studies to determine where further cooperative efforts could be undertaken. 2) A joint U.S.-French man-in-the-sea experiment, in cooperation with West German scientists, used the German underwater laboratory Helgoland this summer in the Baltic Sea. Its purpose was to investigate new instrumentation techniques, ocean processes, and marine organisms on the sea floor. 3) Exchange of information of the effects—beneficial as well as harmful—of thermal effluents, emitted from major water-sited facilities. 4) To acquaint the French with the controlled ecosystem pollution experiment (CEPEX), in which 10-meter by 30-meter "balloons" are being employed under the sea and to help determine the growth and development of natural populations of marine organisms and to study the impact of pollutants upon them.

Other areas in which the two nations are cooperating are coastal processes, marine pollution, man-in-the-sea, manganese nodules, instrumentation, buoy technology and air-sea interaction, and aquaculture.

COASTAL PROCESSES

Planning and experiments will be undertaken on the coasts and shelves

of both nations to distinguish between the effects of natural and man-induced changes in patterns of erosion and sedimentation, such as may be caused by the construction of offshore installations.

Better understanding of the nature of suspended fine sediment transport in estuaries and on the Continental Shelf is needed to determine the effect of dredging and waste disposal on marine life.

MARINE POLLUTION

Three major areas of effort have been planned: the prevention and control of oil spills, remote sensing of pollution in the marine environment, and pollution prevention equipment for ships required by international agreements.

Specific plans include: 1) A workshop in the United States to review the operational utility of the Chemical Hazard Response Information System; 2) an exchange of U.S. and French oil containment barriers with oil-skimming capability for cooperative testing; 3) testing in the United States of the French Cyclonet oil recovery device; 4) operational evaluation in the U.S. of France's Caiman system for storing recovered oil; 5) and the exchange of experts to witness testing of pollution control equipment.

MAN IN THE SEA

The medical problems associated with working under the sea will be attacked on several fronts: 1) The U.S. and France will conduct experiments to increase understanding of the neurophysiological changes which accompany compression to great depths, with exchange observers and study. 2) Both countries will analyze reports of U.S.-French experiments to evaluate how intervascular bubble detectors can help understand decompression, inert gas exchange, bubble formation, and decompression sickness. 3) Information will be exchanged toward better understanding of respiratory physiology at great depths. 4) Work will be continued on the causes of aseptic bone necrosis in diving, and to eliminate it as a diving problem. 5) Plans will be made to develop experiments on cold, high-pressure environmental tolerance. 6) The two nations will cooperate to formulate and establish international safety and operational standards for use of submersibles and for diving.

BUOY TECHNOLOGY AND AIR-SEA INTERACTION

Joint experiments with drifting buoys have been conducted successfully. Information exchange on technology development and program plans, particularly with drifting buoys, will be continued. These joint experiments have provided scientific observations on the cyclonic circulation of water in the Gulf of Biscay. Tentative plans for other joint at-sea experiments were made. The feasibility of borrowing a French-designed spar buoy hull for evaluation in ongoing U.S. developmental programs was discussed.

AQUACULTURE

Collaborative efforts will be undertaken with oysters, shrimp, and coho salmon. Exchange visits will be made, information and techniques exchanged, and the United States will continue to arrange the supply of coho salmon eggs to France. Jointly-conducted pathology experiments for treatment of disease by vaccination will be considered.

MANGANESE NODULES

Basic scientific investigations will be made into the causes of the formation of manganese nodules, mineral concretions on the ocean floor. Plans were made to exchange data and to take measurements using bottom-emplaced ocean monitoring instruments. The possibility of joint cruises will be explored.

INSTRUMENTATION

Programs will be undertaken to establish comparability in ocean data of common interest through intercomparison of techniques used for testing and calibrating current meters and salinity-measuring instruments. The development of computerized cataloging systems for instrument manufacture and performance information will be continued. Specific information will be exchanged on development work and performance of acoustic current meters and buoy-mounted anemometers.

U.S. Fishery Exports Set Record in 1975

U.S. exports of edible and nonedible fishery products reached a record high of $304.7 million during 1975, according to preliminary figures released by the National Oceanic and Atmospheric Administration (NOAA). This was 16 percent greater than 1974 exports and was due primarily to an increase of more than $72 million in the export of edible fishery products.

A record 568.2 million pounds of tuna valued at $152.8 million were landed by U.S. fishermen in Puerto Rico, American Samoa, and the United States. It was a gain of 17.1 million pounds over 1974, but a decrease in value of $10.9 million compared to the record value set in 1974. The larger harvest was due primarily to an increase in landings of tuna in Puerto Rico, while lower prices paid to fishers for their catches accounted for the decrease in value.

The Commerce Department agency reported that the total commercial landing at ports in the United States was 4.8 billion pounds, valued at a record $970.8 million. The quantity landed was two percent less than in

The 1975 top 10 ports in commercial fish landings (in millions of pounds) and in terms of value of landings (in millions of dollars).

Port	Landings	Port	Value
San Pedro, Calif.	594.5	San Pedro, Calif.	[1]82.5
Cameron, La.	395.0	New Bedford, Mass.	31.3
Pascagoula-Moss Point, Miss.	242.6	Brownsville, Tex.	30.0
Dulac-Chauvin, La.	204.2	Kodiak, Alaska	23.6
Empire, La.	176.9	Aransas Pass, Tex.	23.0
Morgan City, La.	140.2	Dulac-Chauvin, La.	19.8
Gloucester, Mass.	126.4	Cameron, La.	17.9
Kodiak, Alaska	99.5	San Diego, Calif.	17.1
San Diego, Calif.	68.7	Gloucester, Mass.	14.5
New Bedford, Mass.	68.6	Astoria, Oreg.	14.0

[1]Record figure.

1974, primarily because of smaller landings of menhaden.

The United States imported edible and nonedible fishery products in 1975 valued at $1.6 billion, a decrease of four percent from record high imports in 1974. The decrease was due chiefly to much smaller imports of raw tuna for canning which more than offset a moderate increase in imports of frozen fish blocks and fish fillets.

According to the National Marine Fisheries Service's statistics, the domestic shrimp industry was the most valuable fishery and accounted for 23 percent of the total exvessel value of U.S. landings. The value of the shrimp landings was $226.2 million, up 27 percent over 1974.

Details of these and other preliminary data dealing with U.S. fisheries are included in Fisheries of the United States, 1975. Single copies may be ordered from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402, for $2.20.

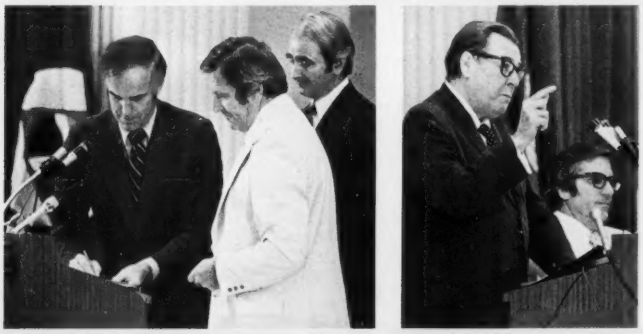
Washington State Coastal Management Program Wins Federal Approval, First Implementation Grant

A $2 million grant for implementation of the nation's first federally approved coastal management program was awarded to the State of Washington on 14 June, Commerce Secretary Elliot L. Richardson has announced. The grant is administered by the Office of Coastal Zone Management of the Commerce Department's National Oceanic and Atmospheric Administration (NOAA).

The grant and approval, Secretary Richardson said, were awarded to Washington for "successfully completing a program that meets the requirements of the Coastal Zone Management Act of 1972." Congress passed the Act to encourage and assist states to exercise their full authority over coastal lands and waters through the development of programs to enhance the balanced and beneficial use of the coast.

In passing the Act, the Secretary noted, Congress recognized that the nation's shorelands, rich in natural resources and esthetic beauty, are often also the scene of a great diversity of resource and economic values, which are threatened by conflicting use demands. Under the Act, coastal states and territories may receive an annual grant for three years to develop their programs and additional funds to implement the plan after it has been approved. Thirty-four states and territories are eligible to participate in the program, including the states bordering the Great Lakes. State participation is voluntary under the Act, which is administered by NOAA's Office of Coastal Zone Management.

To assist Washington in developing its program, OCZM has awarded the state approximately $1.2 million over the past two years on a two-thirds, one-third federal-state matching basis, with Washington State contributing an estimated $600,000. In two years, OCZM has awarded 33 states and territories nearly $30 million to develop coastal management programs.



NOAA Deputy Administrator Howard W. Pollock (center) and Assistant Administrator for Coastal Zone Management Robert W. Knecht (right) watch as Washington State's Governor Daniel J. Evans signs document to acknowledge receipt of a $2 million implementation grant from the Office of Coastal Zone Management at ceremonies in Seattle on 14 June. Pollock also presented Governor Evans a certificate honoring the Washington State coastal zone management program as the first in the nation to receive NOAA approval. U.S. Senator Warren G. Magnuson (right photo) delivered the keynote address.

In mid-June, ceremonies in Seattle to formally award the grant, NOAA Deputy Administrator Howard Pollock said: "Approval of the Washington program has brought the state into a more direct and meaningful working relationship with federal agencies through the requirements for federal consultation and coordination. As a result of this process and the requirements of the CZM Act, federal activities must now be consistent with the state's program, to the maximum extent practicable."

The approved Washington program will serve to guide future coastal growth and development. Final approval of the program occurred one year after NOAA awarded the program preliminary approval, and almost five years after state voters ratified the Washington Shoreline Management Act in a 1971 referendum.

Robert W. Knecht, NOAA Assistant Administrator for Coastal Zone Management, explained that the preliminary approval provided recognition that Washington had substantially complied with the criteria for program management, but had not fully developed its federal consultation procedures or organizational network for implementing the program. "Once the network was fully developed," Knecht emphasized, "Washington's program became eligible for federal approval and financial support for administration."

Washington's Shoreline Management Act provides the basis for the approved state program, and an innovative method for achieving effective coastal management. In addition to providing balanced control of Washington's shorelands by state and local governments, the Act required that a survey be made of the Washington coast, that development of all streams and lakes over 20 acres in size, floodways, deltas, and wetlands come under the purview of

the Department of Ecology, that the state have authority to review substantial development actions under the Act, and that local governments administer permits to use the shorelines, with the state having a right of appeal against those not conforming to regulations.

The award to Washington is considered a crucial turning point in the implementation of a unique federal, state, and local partnership. It marks the beginning of the transition between planning and implementation, and provides assistance to all levels of government to carry out their plans in a coordinated and comprehensive manner. The Washington program approval will further assist in reconciling the additional pressures facing coastal jurisdictions, from the offshore exploitation and transportation of petroleum and mineral reserves.

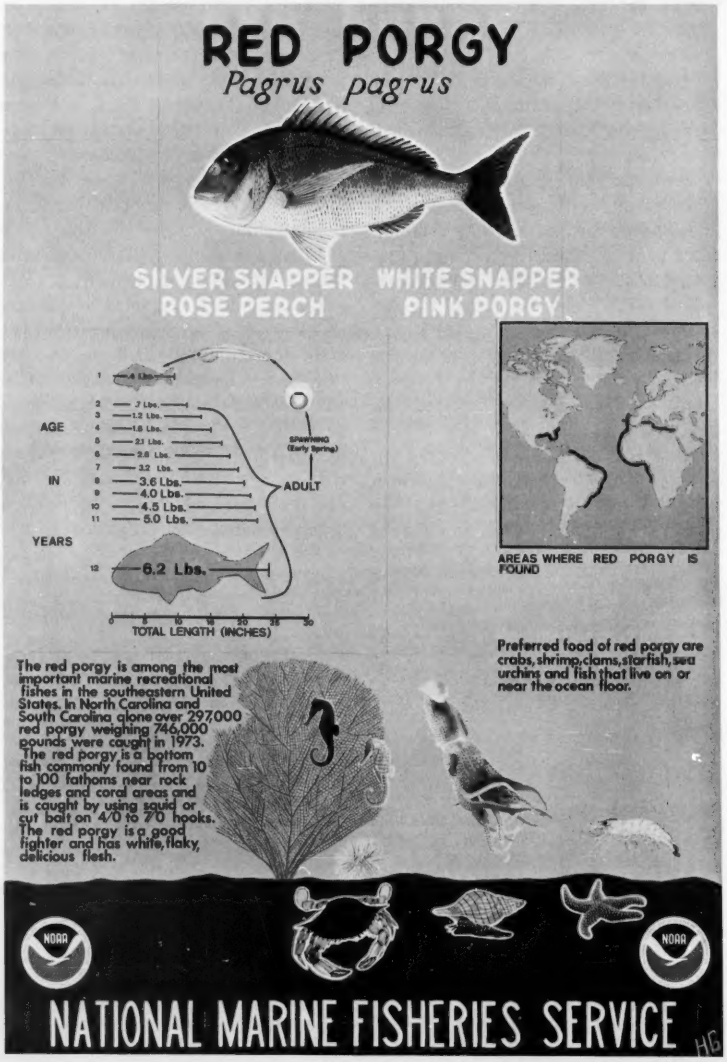
As its matching share Washington will add $1 million to the $2 million NOAA grant. The total coastal management program funds will be used to: 1) enhance the role of local governments in the areas of program administration and enforcement, preparation of the environmental impact statements, revising and refining local master programs as a result of impacts of the state program, conducting special studies of particular concern to local communities, and other supporting activities; 2) encourage regional coordination, among several local governments, for consolidated and detailed management planning for the Columbia River Estuary study, the Hood Canal Advisory Commission, Grays Harbor Regional Planning Commission, and Clallam/Port Angeles supertanker study; 3) support the hiring of several staff persons for liaison with key state agencies to provide a direct relationship between the coastal management program and other state environmental management activities; 4) establish closer federal agency coordination and a conflict resolution mechanism to ensure federal consistency with the approved state program, and continued consideration of the national interest; 5) standardize coastal resource data through the preparation of a coastal zone atlas to provide needed data for improved management decisions; 6) develop model ordinances and refine guidelines for marine water areas, the Outer Continental Shelf, and the second tier of the coastal boundary; and 7) improve policy in regard to the state's energy role, and on amendments to the Coastal Zone Management Act now in House-Senate conference committee, and other activities.

Washington Governor Daniel J. Evans has designated the Department of Ecology as the lead state agency to administer the grant funds.

New Bottomfish Poster Series Printed By NMFS

"Red Porgy," the first in a series of National Marine Fisheries Service posters depicting salient aspects of the life history of important southeastern U.S. offshore bottom fish has been produced by the Atlantic Estuarine Fisheries Center (AEFC), Beaufort, N.C.

The color poster was developed by Herb Gordy, Charles Manooch, and Gene Huntsman of the AEFC and Bob E. Finley, Director of NOAA's National Fishery Education Center, Chicago. The poster provides the scientific name and common names of the


RED PORGY
Pagrus pagrus
SILVER SNAPPER
ROSE PERCH
WHITE SNAPPER
PINK PORGY
AGE
IN
YEARS
.4 Lbs.
.7 Lbs.
1.2 Lbs.
1.8 Lbs.
2.1 Lbs.
2.8 Lbs.
3.2 Lbs.
3.6 Lbs.
4.0 Lbs.
4.5 Lbs.
5.0 Lbs.
6.2 Lbs.
SPAWNING (Early Spring)
ADULT
TOTAL LENGTH (INCHES)
AREAS WHERE RED PORGY IS FOUND
The red porgy is among the most important marine recreational fishes in the southeastern United States. In North Carolina and South Carolina alone over 297,000 red porgy weighing 746,000 pounds were caught in 1973. The red porgy is a bottom fish commonly found from 10 to 100 fathoms near rock ledges and coral areas and is caught by using squid or cut bait on 4/0 to 7/0 hooks. The red porgy is a good fighter and has white, flaky, delicious flesh.
Preferred food of red porgy are crabs, shrimp, clams, starfish, sea urchins and fish that live on or near the ocean floor.
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species, its geographic distribution, length and weight by age, time of spawning, important foods, and information pertaining to the fishery off the southeastern United States. The four-color poster has been reproduced photographically in two sizes of prints on heavy paper: 20 x 24 inches and 16 x 20 inches.

Official copies are being placed at boat docks, marinas, and other centers for marine anglers by NMFS recreational fishery personnel. Additional copies are available in a limited supply from the National Marine Fisheries Service, Atlantic Estuarine Fisheries Center, Beaufort, NC 28516. Future posters in this series will include the vermilion snapper, white grunt, red grouper, scamp grouper, and perhaps others.

Outstanding NMFS Papers Are Honored

The outstanding papers authored by National Marine Fisheries Service scientists and published in the *Fishery Bulletin* and the *Marine Fisheries Review* in 1974 have been selected by the NMFS Publications Policy Board. The respective authors shared Special Achievement Awards for their work.

William H. Lenarz, William W. Fox, Jr., Gary T. Sakagawa, and Brian J. Rothschild received a Special Achievement Award for their paper "An Examination of the Yield Per Recruit Basis for a Minimum Size Regulation for Atlantic Yellowfin Tuna, *Thunnus albacares*." It appeared in the January 1974 issue of *Fishery Bulletin* (Volume 72, Number 1). Lenarz is with the Tiburon Laboratory, Southwest Fisheries Center, NMFS, NOAA, Tiburon, Calif. Fox and Sakagawa are with the Southwest Fisheries Center, NMFS, NOAA, La Jolla, Calif. Rothschild is currently attached to the Extended Jurisdiction Planning Staff, NMFS, NOAA, Washington, D.C.

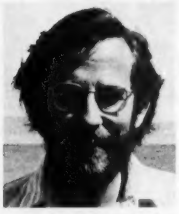
Sharing the second Special Achievement Award were Timothy Joyner, Conrad V. W. Mahnken, and Robert C. Clark, Jr. for their paper "Salmon—Future Harvest from the Antarctic Ocean?" published in the May 1974 issue of *Marine Fisheries Review* (Volume 36, Number 5). Joyner, now a Fisheries Consultant, was formerly employed at the Northwest Fisheries Center, NMFS, NOAA, Seattle, Wash. Mahnken and Clark are with the Northwest Fisheries Center, Seattle, Wash.

Austin B. Williams received Honorable Mention for his *Fishery Bulletin* paper, "The Swimming Crabs of the Genus *Callinectes* (Decapoda: Portunidae)" (Volume 72, Number 3). Williams is with the National Systematics Laboratory, NMFS, NOAA, Washington, D.C. Warren F. Rathjen won Honorable Mention for "New England Fisheries Development Program" in the November 1974 issue of *Marine Fisheries Review* (Volume 36, Number 11). Rathjen is with the Northeast Regional Office, NMFS, NOAA, Gloucester, Mass.

Developed in 1975, the NMFS publications awards program recognizes NMFS employees who have made outstanding contributions to the knowledge and understanding of the resources, processes, and organisms studied as part of the NMFS mission. *Fishery Bulletin* papers must document outstanding, original scientific work while *Marine Fisheries Review* papers must be effective and interpretive in contributing to the understanding and knowledge of NMFS mission-related studies.

Any NMFS employee may recommend publications of the appropriate calendar years to the Publications Policy Board for award consideration. Authors must have been employed by the NMFS at the time the paper was published. Nominations, solicited by 1 April each year, must include the author's name, paper title and number of pages, series name and/or volume, justification to support the nomination, and the name and office affiliation of the nominator.

Another 1974 *Fishery Bulletin* paper, "Feeding Relationships of Teleostean Fishes on Coral Reefs in Kono, Hawaii," by Edmund S. Hobson, Jr., was chosen by The Wildlife Society for its


Lenarz

Fox

Sakagawa

Rothschild

Joyner

Mahnken

Clark

Williams

Rathjen

Hobson

1976 Fisheries Publication Award. The paper appeared in Volume 72, Number 4 of the *Fishery Bulletin*, pages 915-1031. Hobson is with the Tiburon Laboratory, Southwest Fisheries Center, NMFS, NOAA, Tiburon, Calif.

Hannum Joins NOAA's Washington Staff

William B. Hannum, Jr., former President and Chairman of the Board of Sea Farms, Inc., Key West, Fla., has been named Staff Assistant in the Living Resources Office of the Associate Administrator for Marine Resources, National Oceanic and Atmospheric Administration (NOAA).

Hannum founded Sea Farms, Inc., and for more than 10 years guided its activities in operating fishing fleets; producing, processing, and selling sea foods; and, developing aquaculture in the United States and Central and South America. Earlier, while employed as District Manager of *Chemical Week* magazine, he developed a process for raising shrimp that is now in broad use. His many years in the seafood industry and allied areas will support efforts being made by the Department of Commerce in maintaining an ecological balance between marine life and human needs.

In his new Marine Resources position in Washington, D.C., Hannum will be responsible for reviewing and evaluating policies and procedures which relate to the seafood industry and to marine environment.

Originally from Philadelphia, Pa., Hannum attended Pennsylvania State College and Drexel Institute, and has held numerous offices and memberships in nationally recognized fishery associations. He was a member of the Marine Fisheries Advisory Committee of the National Marine Fisheries Service and of NOAA's Coastal Zone Management Advisory Committee. Hannum is married to the former Louise McKee, also of Pennsylvania. They have two children: William B. Hannum, III, and Barbara H. Mount, and two granddaughters. The Hannums now live in Gaithersburg, Md.

Foreign Fishery Developments

Canada: Extended Fisheries Jurisdiction Enforcement Plans, and New Fishery Budget

The Canadian Government announced on 4 June that it would unilaterally extend its fisheries jurisdiction to 200 nautical miles not later than 1 January 1977. The action was unexpected, as Canada has consistently spoken against unilateral actions before the U.N. Law of the Sea Conference is concluded.

External Affairs Minister MacEachen, in announcing the new fisheries limits, cited Canada's need to protect its resources and its fishers, as well as recent U.S. and Mexican extensions of fishery jurisdictions. (The United States will extend to 200 miles on 1 March 1977; Mexico did so on 31 July.) MacEachen said: "There will be no fishery resource left to protect if action is not taken now because the fish stocks will be so depleted as to disappear as a resource of commercial significance. Not only the fish, but our Canadian fishermen, too, are an endangered species."

BILATERAL AGREEMENTS

Canada continued to press for an international solution to fisheries management at the U.N. Law of the Sea Conference in New York but had already signed bilateral fishery agreements with Spain, Portugal, Norway, Poland, and the Soviet Union, nations which fish heavily in Canadian waters, in anticipation of extended jurisdiction. Foreign fleets will be allowed to fish within the new limits for stocks that are surplus to Canadian fishing capacity. Catch quotas for foreign fishermen, however, had not been set by early summer.

The United States and Canada have a reciprocal fisheries agreement which was extended through April 1977, but further negotiations on mutual fishing rights in each other's extended jurisdictions will take place.

In a related development, Minister of Fisheries Roméo LeBlanc also announced that Canada intended to withdraw from the International Commission for the Northwest Atlantic Fisheries on 31 December 1976. The Canadian Government will not necessarily leave the organization, but is retaining its option to do so if future multilateral agreements are not satisfactory to the Canadians. The United States has also announced its intention to withdraw from ICNAF on 31 December. (Source: U.S. Embassy, Ottawa; and the *Washington Post*.)

ENFORCEMENT PLANS

Fisheries patrols are being doubled this year and this increased level will ensure Canada's capability to control fishing activity throughout its new 200-mile fishing zone, according to Minister of State for Fisheries Roméo LeBlanc.

Fisheries and Marine Service of Environment Canada, now carrying out 90 percent of Canada's fisheries patrol work in offshore waters, will call more extensively on ships and aircraft from the Department of National Defence (DND), Environmental Canada reports. DND already provides substantial support to fisheries patrols. In addition, vessels from the Ministry of Transport fleet will become available on a regular basis. The Fisheries and Marine Service will retain overall responsibility for fisheries surveillance and enforcement.

In 1976 the number of sea-days on patrol by vessels on both coasts will roughly double to about 2,000. Offshore patrols will increase on the Pacific coast to about 500 sea-days, and will double on the Atlantic coast to about 1,500 sea-days. The number of boardings of fishing vessels at sea by Canadian inspectors will increase to between 1,200 and 1,400 per year permitting at-sea inspection of at least one-third of the foreign fleet and one-sixth of the Canadian fleet every month.

The number of aircraft hours spent locating and identifying fishing vessels will more than double to over 4,000 per year. Except for some previous charters of private aircraft by the Fisheries and Marine Service, DND Tracker and Argus aircraft have provided all air

Canada's Fisheries and Marine Service fleet[1].

Type of vessel	Atlantic Coast	Inland waters	Pacific Coast
Fisheries Conservation and Protection vessels			
Over 100 feet			
Now operating	4	—	3
Being prepared	4	—	—
From 20-100 feet	43	6	51
Fisheries and Oceanographic/Hydrographic Research and survey vessels			
Over 100 feet			
Now operating	6	2	4
From 20-100 feet	46	57	44

[1] The total Fisheries and Marine Service fleet, about 600 vessels, ranges from small boats and launches to deep-draft, ocean-going ships, and employs approximately 1,200 people. It is the second-largest civilian-manned government fleet in Canada. (Source: Environment Canada.)

surveillance. Air patrols by DND will now increase sufficiently to locate and identify every fishing vessel in Canada's offshore zone at least once per week, and will keep an even closer watch over key areas where fishing boundary lines cross rich fishing banks.

Canadian vessels also will maintain a special presence in these parts of the fishing grounds. Fisheries and Marine Service vessels will carry out about 56 percent of sea patrols, DND vessels about 31 percent, and MOT vessels about 13 percent. Increased operational and maintenance costs of air and sea fisheries patrols for all departments will be covered by a special Fisheries and Marine budget of $4 million in 1976-77.

"We anticipate smooth and effective extension of jurisdiction," LeBlanc said. "We have already signed agreements with major fishing nations off our coast, confirming that in the new zone they'll accept our authority immediately. We will be able to say who fishes what, where, when, and how much. We will have the power to license foreign vessels, to restrict foreign vessels to certain areas, to impose reporting requirements, to lift their licenses if need be, to seize ships for violations of regulations, and to impose fines and sentences in our own courts."

LeBlanc also praised the work of Fisheries and Marine Service vessels under extraordinary demands last year. "In increasing the number of patrols after the temporary port closure to some foreign fishing vessels last fall, I even diverted fisheries and oceanographic research vessels temporarily into fisheries patrols. I was pleased to find their crews shared with some other arms of the Fisheries and Marine Service an interest and expert knowledge at this work. Fisheries and oceanographic research, management, and enforcement relate closely to one another; this helps lower the cost of effective surveillance. For example, our knowledge of fishing patterns helps us calculate foreign catches in relation to quotas. We have built up coordination and cooperation between our vessels and the fishing fleets; we can easily extend this same coordination to fleets of other federal departments. The government's decision to let us call on the aircraft and ships of other departments will ensure adequate surveillance and enforcement."

The regular fleet of fisheries patrol vessels built for the purpose will also gain strength, said LeBlanc. A new vessel, the *Cape Roger* (see box below), will carry a helicopter for more effective surveillance and coordination with other elements of the fisheries surveillance fleet. Two high-speed, aluminum, 120-foot patrol vessels are also under construction for use on the Atlantic coast. One will be in service before the end of the year. In addition, Fisheries and Marine Service expects to acquire another vessel suitable for ocean-going patrol work in the near future.

Canada Builds Biggest Fishery Patrol Ship

The largest fisheries patrol vessel ever built in Canada—the 205-foot *Cape Roger*—was launched from Pictou, Nova Scotia, on 12 June. To be based at St. John's Nfld., the $12 million vessel is scheduled to join the Fisheries and Marine Service's patrol fleet in mid-1977.

Besides fishery surveillance, the *Cape Roger* is equipped to conduct fisheries, oceanographic, and hydrographic research. It will have special deicing equipment installed on the superstructure. A maximum speed in excess of 16.5 knots, together with launching facilities for a Bell "Jet Ranger"-type helicopter, will permit continuous surveillance of large areas of the fishing grounds. The *Cape Roger* will have crew accommodation for 42, including up to 6 scientific personnel and 2 helicopter pilots. (Source: Environment Canada.)

Canadian inspections under ICNAF Joint Inspection Scheme[1], 1975.

Nation	Inspections	Violations
West Germany	5	0
Poland	10	1
Spain	59	14
USSR	274	18
Norway	5	1
Japan	4	2
East Germany	8	1
United States	14	5
Bulgaria	1	1
Cuba	1	0
France	3	1
Iceland	1	1
United Kingdom	1	1
Mexico	1	0
Portugal	28	12
Romania	2	0
Total foreign	417	48
Canadian vessel inspections	57	

[1] Besides the infringements by individual fishing vessels noted above, Canadian patrols detected other offenses on a fleet-wide scale. (Source: Environment Canada.)

"Our agreements with foreign countries, and our strengthened patrols, indicate that when we extend jurisdiction we'll do it effectively," LeBlanc said. "In the meantime, our patrols will continue to operate under the ICNAF (International Commission for the Northwest Atlantic Fisheries) Joint Enforcement Scheme." LeBlanc also reminded Canadian fishers that they are still expected to cooperate with fisheries inspectors, whether Canadian or foreign, who may board their vessels under that scheme. (Source: Environment Canada.)

NEW FISHERY BUDGET

The Canadian budget for the Fisheries and Marine Service in 1976-77 is estimated to be approximately C$261 million[1], a 25 percent increase over 1975-76 planned expenditures of C$208 million[2]. The budget for the Fisheries and Marine Service now represents 52 percent of the entire Department of Environment budget, a small percentage increase over last year's allotment. Total employment estimates have been set at 4,904 man-years, an increase of 143 positions from 1975-1976.

Capital spending comprises over 22

[1] US$1.00 = C$1.0006.
[2] Canada's fiscal year is from 1 April to 31 March.

percent of the budget with most of the C$59 million allocated for vessel and harbor construction and for research projects. Operating expenditures will account for more than 59 percent of the budget (C$155 million) with C$133 million allocated for fisheries management and research and C$42 million for activities in aquatic and ocean sciences. Economic assistance to the groundfish industry and other depressed sectors of the fishing industry amounts to over C$40 million, or 15 percent of the total fisheries budget.

In anticipation of extended jurisdiction effective 1 January 1977, Canada has provided C$9 million for patrol ship construction and C$10 million for a helicopter-equipped patrol vessel now under construction. For a six-page expanded summary of the Canadian budget, write R. V. Arnaudo, Office of International Fisheries, F41, NMFS, NOAA, Department of Commerce, Washington, DC 20235.

EC Drafts 200-Mile Limit Position Paper

The European Communities (EC) Commission drafted its position on EC fisheries policy and forwarded it to the EC Council on 26 February 1976. It is entitled "Problems which the Introduction of Economic Zones of 200 Miles Poses for the Community in the Sea Fishing Sector." The paper calls for Community control of fisheries within 200 miles of EC-members' borders, and establishes the principle that conservation of fish stocks is a collective Community responsibility, and not the sole concern of any one Member State.

The Council, acting on the advice of the Commission, would establish annual catch rates for selected species within Community waters to be based on the principle of optimal sustainable yield and as determined by the Council. A Scientific and Technical Committee for Fishing is to be established to estimate stocks and recommend measures for their conservation, as well as to prepare "periodic" reports on the status of the fishery.

Member states will be authorized to extend their coastal fishing zones from 6 to 12 miles. The resources within the zone of 12 to 200 miles, however, will be managed by the EC Commission, with quotas allocated to countries on the basis of past catches. Quotas assigned can be exchanged among Member states.

The paper makes reference to "vessels which fish traditionally" in the new 6 to 12 mile zone, asking that "fishing rights . . . should be gradually eliminated in these new reserved zones." In other words, the phase-out of traditional foreign fisheries within 12 miles of EC coastal states is foreseen and the adjacent state will eventually have exclusive fishing rights in that area. The paper suggests that "The member state affected by this gradual elimination of fishing rights could, in this particular case, benefit from compensation in the form of . . . aid measures." The Commission paper also suggests that negotiations should begin with nonmember countries which fish in EC waters, "on the assumption of a general extension of fishing limits to 200 miles." These negotiations need not concern only reciprocal fishing rights or trade concessions, "but also any other subject which could yield balanced results." Finally, the Commission notes that its proposals are closely related to the position the Community should adopt at the UN Law of the Sea Conference. It proposes that the Community should be a contacting party to the Convention. (U.S. EC Mission, Brussels.)

According to the NMFS Office of International Fisheries, the proposal submitted by the EC Commission to the EC Council will undoubtedly undergo many changes before it becomes official EC policy. The United Kingdom and Ireland, for example, have already expressed interest in larger individual fishing zones than the 12 miles called for in the paper.

Additionally, the issues of negotiations with third countries, subsidies to Member states which are to be phased out of traditional grounds, and the reference period from which quotas will be allocated, are expected to produce a vigorous debate.

MEXICO CLOSES TOTOABA FISHERY

The Mexican Government, alarmed by declining totoaba (*Cynoscion macdonaldi*) catches, has proclaimed a 2-year ban on fishing for the species, the NMFS Office of International Fisheries reports. The ban applies to sport and commercial fishing and violations carry penalties of up to US$4,000. The totoaba, or MacDonald weakfish, is found only in the China Sea and in the northern Gulf of California near San Felipe (see map).

Totoaba is popular in seafood restaurants in Southern California. The fishing ban, however, will not affect the San Diego market as much as some people have predicted. "Some restaurants in Southern California have been serving other Gulf of California fish instead of totoaba for some time, and most customers could not tell the difference," an official in the Mexican Fisheries Subsecretariat stated.

The totoaba spawns in the shallow marshes at the mouth of the Colorado River. Mexican biologists have been warning that overfishing and the diversion of the Colorado River into the Mexicali Valley after the Morelos Dam was built, would drastically reduce the totoaba catch. After the river was diverted into the Mexicali Valley, the marshes began drying up and the totoaba's spawning grounds have been significantly reduced. Another report indicates that the totoaba may also have been affected by insecticides used by U.S. and Mexican farmers along the Colorado River.

According to the NMFS Office of In-

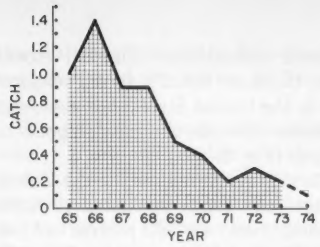


Figure 1.—Mexico's totoaba catch, 1965-73, in thousands of metric tons. Data for 1974 is estimated. (Source: "FAO's Yearbook of Fishery Statistics," various years.)

ternational Fisheries, catches of totoaba in excess of 2,000 metric tons were reported in the early 1940's. Since 1966, however, these catches continued to decline sharply and amounted to only 200 metric tons in 1973 (Fig. 1). Unconfirmed reports suggest that the 1974 catch was only approximately 100 metric tons. Over half of the totoaba catch formerly was exported to the United States.

Prior to the Mexican Government's declaration of the totoaba fishing ban, several limited measures had been taken to protect the fishery. A refuge was established in the northern Gulf of California where totoaba fishing was prohibited. A seasonal closure of totoaba fishing in the entire Gulf of California was enforced from 1 April to 15 May. Apparently these measures were not adequate to allow the recovery of totoaba stocks and the government felt that a complete closure of the fishery was necessary.

The totoaba was endangered once before in the late 1950's. After fluctuating wildly in the late 1930's, the annual catch of totoaba began to decrease constantly in 1942 from a level of 2,250 metric tons and by 1957-58 only about 250 metric tons were caught each year. Various conservation measures brought the annual catch back to almost 1,500 metric tons in 1966. However, the totoaba catch has since declined steadily (Fig. 1). In view of the past successes, it is hoped that the new stringent conservation measure will effectively protect Mexico's totoaba resource.

BRAZILIAN SHRIMPING CONTINUES TO EXPAND

The Brazilian shrimp fishery has expanded significantly since 1967 when the shrimp catch amounted to 37,160 metric tons. By 1974, this catch had increased to an estimated 57,190 metric tons or by nearly 54 percent (Fig. 1, Table 1). The pattern of increase over this 8-year period was not steady, but fluctuated due to declining catches in 1969 and 1973.

The fluctuations in the shrimp catch are, in great part, due to the conditions of the central and southern fishing areas, where Brazilian fishermen catch most of their shrimp. Northern Brazil offers rich opportunities for shrimping, especially in the area near the mouth of the Amazon, where the river's rich nutrients flow into the ocean. Foreign fishermen have operated in the north for years. In 1975, Brazil concluded fisheries agreements on shrimp with the United States, Surinam, Barbados, and Trinidad and Tobago[1] (Fig. 2). These agreements permit the following numbers of foreign shrimp vessels to operate in the shrimp agreement area during 1975: Barbados, 22; Surinam, 23; Trinidad, 28; and the United States[2], 160.

In 1967, the Food and Agriculture Organization (FAO) of the United Nations, in cooperation with the Brazilian Government, published a report on the shrimp fisheries of central and southern Brazil. Their findings showed that the shrimp stocks were underexploited and that harvesting equipment and methods in these fisheries were inefficient. Other problems cited were inadequate fishing ports, poor unloading methods, insufficient storage and transportation facilities, and lack of processing plants and qualified crews.

In an effort to deal with these problems, the President issued Decree Law[3] 221 in February 1976, which

Table 1.—Brazil's shrimp catch and exports to the United States, 1967-74 in thousands of metric tons.

Year	Catch	Exports to U.S.	Percentage
1967	37.16	0.11	0.29
1968	47.07	0.16	0.33
1969	44.00	0.18	0.40
1970	43.68	1.18	2.70
1971	44.36	2.00	4.51
1972	56.76	4.05	7.41
1973	53.86	1.93	3.58
1974	57.19 (est.)	1.35	2.36

Sources: *Revista Nacional da Pesca*, and the U.S. Department of Commerce, *Fisheries of the United States*.

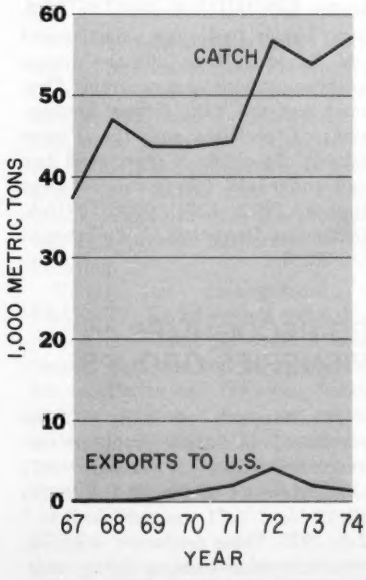


Figure 1.—Brazil's shrimp catch and exports to the United States, 1967-74, in thousands of metric tons.

Figure 2.—The Brazilian shrimp fishing agreement area.

[1]On 29 October 1975 four U.S. shrimp trawlers were seized for shrimping outside the agreement area and for failing to maintain proper documentation.
[2]According to the text of the shrimp agreement between the United States and Brazil, a maximum of 160 shrimp vessels are allowed to operate at any one time in the agreement area.
[3]"Decreito-lei" or Decree Law refers to a legislative act which originates in the executive branch.

Table 2.—Major importers[1] of Brazilian shrimp, 1972-73.

Country	Shrimp imports[2] 1972	1973
South Africa	103	21
Argentina	139	36
Belgium	10	—
Canada	7	—
Spain	25	31
United States	4,130	1,925
France	159	—
Italy	1	—
Japan	2,088	594
Netherlands	18	6
Portugal	—	5
United Kingdom	22	4
Total	6,702	2,622

[1]Source: *Revista Nacional da Pesca.*
[2]Quantities listed in thousands of metric tons.

provided fiscal incentives to assist the expansion of fish-processing plants through investment tax credits and sought to encourage the use of tax incentive funds to establish new fishing companies. This program has since been expanded to encompass additional goals. For example, in 1972 funds were appropriated to improve fishing port facilities, establish research projects, set up training programs for fishermen, diversify fish exports, initiate educational campaigns on human dietary requirements, provide economic and social assistance to colonies of artisanal fishermen, improve law enforcement and conservation practices, and expand aquaculture and the production of fishmeal. The fiscal incentives supplied an impetus for the growth of the Brazilian fishing industry. The total fisheries catch increased from 420,000 metric tons in 1967 to an estimated 590,000 metric tons in 1973.

The introduction of fiscal incentives in the fishing industry significantly affected the Brazilian shrimp industry. The expanded commercial fishing fleet resulted in overfishing of shrimp in southern Brazil[4] in 1968, depleting the adult shrimp stocks. For example, the harvest of pink shrimp (Camarao de Rosa) in the south declined by more than 47 percent between 1969 and 1971, from 4,612 to 2,430 metric tons. The overall Brazilian shrimp catch, reflecting the results of overfishing in the south, declined to 44,000 metric tons in 1969 and remained below 45,000 metric tons until 1972. By 1974, Brazil's shrimp stocks had recovered and a record catch, estimated at 57,200 metric tons, was harvested. The 1975 catch estimates suggest that a new record may have been set.

Shrimp is now one of Brazil's major fishery exports, although the vast proportion of the shrimp catch is consumed domestically (Fig. 1). About two-thirds of Brazil's shrimp exports go to the United States; however, significant amounts are also shipped to Japan (Fig. 3).

In 1972 shrimp exports to the United States and Japan amounted to 6,200 metric tons or 96 percent of all Brazilian shrimp exports. In 1973 shrimp exports declined along with the catch; however, the United States and Japan still imported 2,500 metric tons, which accounted for 93 percent of all shrimp exports (Fig. 3). In 1974, U.S. imports of Brazilian shrimp continued to decline even though the shrimp catch increased (Fig. 1). Most of Brazil's shrimp exports come from the southern ports which supplied 6,000 metric tons, or 90 percent of all shrimp exports in 1972, and 1,800 metric tons, or 74 percent in 1973 (Table 3). (Sources: U.S. Consulate, Rio de Janeiro, and U.S. Embassy, Brasilia.)

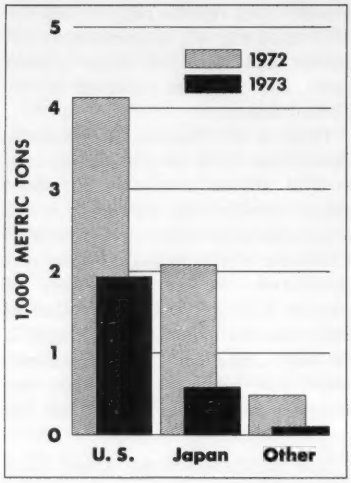


Figure 3.—U.S. and Japanese imports of Brazilian shrimp, 1972-73, in thousands of metric tons.

Table 3.—Brazilian shrimp exports, by point of departure, 1972-1973.

Port	Shrimp exports 1972	1973
South		
Rio de Janeiro	93	67
São Paulo	3	—
Santos	2,496	1,174
S. Sebastião	348	63
Paranagua	841	275
Itajai	405	117
S. Francisco	257	43
Porto Alegre	22	—
Rio Grande	1,411	10
Urugaiana	124	36
Total	6,000	1,785
North		
Belem	702	673
Fortaleza	—	—
Recife	—	1
Total	702	674
Grand total	6,702	2,459

Source: *Revista Nacional de Pesca.*

Leaflet Reports Danish Fisheries

Foreign Fisheries Leaflet 75-2, "Fisheries of Denmark, 1974," has been prepared by the Division of International Fisheries Analysis and is available for distribution. The 11-page leaflet contains information on landings, foreign trade, the reduction and cod fisheries, fleet, fishery limits, government assistance programs, Denmark and the EEC, fishery commissions, Greenland, and the Faeroe Islands. To obtain a copy, send two self-addressed labels to: Services Branch, D825, ESIC, EDS, NOAA, Commerce Department, Washington, DC 20235.

EC RECOGNIZES 44 FISHERIES GROUPS

The European Community (EC) has recognized 44 fishery producers' organizations from 26 January 1971 (when Article 6 of Council Regulation (EEC) No. 170/71 was published) to 1 July 1975. These producers' organizations are either existing fishery marketing cooperatives or new fishery marketing cooperatives that have organized or were organized to handle

[4]"Southern Brazil" refers to the area south of Rio de Janeiro.

the local operations of the EC common organization of the market in fishery products.

Recognized producers' organizations receive grants and reimbursements for carrying on price support activities and diversion programs to obtain the objectives of the EC common organization of the market in fishery products. The number by country and activity are listed in the following table. Names

Country	Activity	No.
Belgium and Luxembourg	Middle-water, near-water, and inshore fishing	1
Denmark	Middle-water, near-water, and inshore fishing	2
Germany	Middle-water fishing	2
	Near-water fishing	9
	Inshore fishing	4
France	Distant-water fishing	2
	Middle-water fishing	6
	Near-water fishing	5
	Inshore fishing	3
	Specialized fishing	3
Netherlands	Middle-water, near-water, and inshore fishing	2
United Kingdom	Distant-water, middle-water, near-water, and inshore fishing	3
	Inshore fishing	2
Total		44

and addresses of these producers' organizations are available from Fred Olson, Office of International Fisheries, NMFS, NOAA, Washington, DC 20235.

USSR Forms New Joint Fisheries Ventures

Representatives of the Soviet Ministry of Fisheries and the French firm Casacruz signed an agreement on 14 October 1975 creating FRANSOV, a joint-stock association, according to the NMFS Office of International Fisheries. The Soviets and the French (Casacruz and two other shareholders) will each provide 50 percent of the financing.

Under the management of FRANSOV, Soviet vessels will fish in the eastern Pacific and south Atlantic oceans. Casacruz will be responsible for negotiating and reviewing fishing licenses in areas where the coastal states require them[1]. The number of vessels fishing will be limited by the licensing nations, not by FRANSOV.

According to a representative of Casacruz, the agreement will not be detrimental to the French fishing industry. Fishery products caught and processed by FRANSOV vessels will not be sold on the French market, but will be exported to Canada and various Asian countries. Profits obtained from these sales will be reinvested in vessels, gear, and equipment manufactured and purchased in France. A projected Casacruz plan to build and equip tuna vessels for the USSR is an example of how FRANSOV would operate. Profits earned by the tuna vessels fishing off Africa would be reinvested by the company to purchase goods and services from French firms.

SPAIN

The Soviet Union and Spain have also agreed to establish a joint fisheries venture. The new firm, called PESCONSA, will reportedly be managed by the Spanish International Export/Import Company, and by SOVHISPAN, a company which represents the Soviet fishing fleet in Spain. PESCONSA offices will be located in Madrid and Las Palmas, Canary Islands. Two Soviet and two Spanish fishing vessels are already under the management of the new company.

According to the NMFS Office of International Fisheries, little is known thus far about this latest venture, but it seems likely that the formation of PESCONSA is related to a recently-announced joint Spanish-Soviet project. SOVHISPAN, with the approval of the Spanish government, is planning to build a US$1.8 million complex in the Canary Islands to service Soviet fishing vessels based there. PESCONSA vessels will probably also be serviced by the new facility.

SOVHISPAN itself is a joint Soviet-Spanish company formed in Barcelona, Spain, in July 1971. The main purpose of the company is to develop the Canary Islands as a supply, crew rotation, and transshipment base for the Soviet fishing fleet. SOVRYBFLOT, the foreign trading branch of the Soviet Ministry of Fisheries, provided 50 percent of the original financing, while two Spanish firms, Tabacos de Filipinas and Vapores Suardiez, provided the remaining 50 percent. At the time of the agreement, relations between Spain and the Soviet Union had been broken for 32 years; SOVHISPAN, therefore, was the first officially sanctioned Spanish-Soviet joint commercial venture since the Spanish Civil War.

CSFR Violation Trips Soviet Stern Trawler

The *Anton Tammsaare*, a Soviet large freezer stern trawler, was seized by U.S. Coast Guard inspectors on 9 March 1976 for a Continental Shelf Fisheries Resource (CSFR) violation according to the NMFS Office of International Fisheries. Inspection of the vessel uncovered 18 lobsters weighing a total of 61.6 pounds. The lobsters were concealed in three holds of the *Anton Tammsaare*, wrapped in paper and burlap sacks, and stashed in empty fish boxes. At the time of the seizure, the vessel was located approximately 120 miles east-southeast of Nantucket Island. Subsequently, it was brought into Boston Harbor under the escort of the U.S. Coast Guard cutter *Vigorous*.

On 11 March 1976, a criminal complaint was filed in Boston against Valentin Eliseev, Master of the *Anton Tammsaare*, and a civil complaint was filed against the vessel. However, the case did not go to trial, but was settled with the payment of a $410,000 penalty. The *Tammsaare* was released on 31 March.

The NMFS Office of International Fisheries reports that the *Anton Tammsaare* is a *Maiakovskii*-class large freezer stern trawler constructed in the Soviet Union in 1962. The vessel, which carries a 90-member crew, is owned by the Western Administration of the Soviet Ministry of Fisheries (Zapryba). Its home port is in Tallinn, Estonia.

The *Anton Tammsaare* is the second Soviet vessel to be seized for a CSFR violation. The first vessel, the *Zaraisk*, was seized off New Jersey on 17 August 1975 with 25 pounds of red and stone crabs on board. That vessel was released with a $100,000 fine.

Seizures for CSFR violations normally are not brought to trial, although a judgement is entered by the court, and settlement is made through the payment of fines. If the case does go to

[1]Fishing licenses are negotiated in hard currency, with the licensing nation determining the fee according to the amount of the catch taken, the value of the vessels, or the value of the catch.

court, under the Bartlett Act (16 U.S. Code 1081-1086), a vessel seized for a CSFR violation is subject to forfeiture together with its gear and catch. In addition, the captain of the vessel can be personally fined up to $100,000, be imprisoned for up to one year, or face both fine and imprisonment.

Peru's 1975 Anchovy Catch Below Average

The Peruvian anchovy catch amounted to 3.1 million metric tons in 1975. This was considerably below the Peruvian Government's forecast of 6 million tons and a decline of 14 percent from the 3.6 million metric tons caught in 1974. Most of the 1975 fishing took place before 15 May 1975 when a seasonal closure was imposed (Table 1).

Peruvian January 1976 stocks of both fish meal and fish oil were considerably smaller than were such stocks in January 1975 (Table 2). The 1976 forecast is an anchovy catch of 4 to 4.5 million metric tons, the production of 0.9 to 1.0 million metric tons of fish meal, and 160,000 to 200,000 metric tons of fish oil. Estimates of 1976 fish meal and fish oil exports are not yet available. However, an increase in fish meal exports is expected. Peru consumes about 80,000 to 100,000 metric tons of fish meal, primarily in the poultry sector. If Peru maintains stocks at the 31 January 1976 level, some 800,000 tons of fish meal could be exported in 1976, or about 50,000 tons more than in 1975. (Source: U.S. Embassy, Lima.)

Table 1.—Anchovy catch, fish meal and fish oil production, and fish meal exports, 1975, in metric tons.

Month	Anchovy catch	Production		Fish Meal exports
		Meal	Oil	
Jan.	249,693	53,656	12,279	48,981
Feb.	348,374	77,153	24,749	34,036
March	897,918	195,031	62,482	44,327
April	881,096	196,349	63,844	20,034
May	568,929	129,003	42,225	84,569
June	13,773	3,104	865	101,110
July	1,485	305	55	104,969
Aug.	1,726	345	33	128,912
Sept.	667	139	3	54,127
Oct.	33,569	7,780	1,437	95,061
Nov.	43,963	10,682	1,850	23,227
Dec.	56,437	12,723	1,418	8,274
Total	3,097,630	686,270	211,240	747,627

Source: U.S. Embassy, Lima.

Table 2.—Stocks of fish meal and fish oil in 1,000 metric tons: 31 Jan. 1976 and 31 Jan. 1975.

Inventories	Fish meal	Fish oil
31 Jan. 1976	92,129	15,554
31 Jan. 1975	216,289	35,512

According to the NMFS Office of International Fisheries, the Peruvian anchovy catch continues at levels significantly below the all-time record of 12.3 million tons reached in 1970 (Fig. 1, Table 3). The precipitous catch decline in 1972 occurred as the result of a weather-related phenomenon, known in Peru as el Niño, which disrupted the normal flow of the Humboldt Current. The last el Niño, which began in April 1972, was one of the most severe ever recorded. The Peruvian fishing industry was hard hit by the scarcity of anchovy and nearly 30,000 people were reportedly out of work. As a result of the crisis, the Peruvian Government nationalized the entire fish meal industry on 7 May 1973. In 1973, the anchovy catch continued to decline reaching a low of 1.8 million metric tons, a decline of 86 percent from the 1970 catch. The 1975 catch, while greater than the disastrous 1973 catch, is still only 25 percent of the 1970 record catch.

Table 3.—Anchovy catch (1960-76) and fish meal production and exports (1965-76) in millions of metric tons.

Year	Anchovy catch	Fish meal	
		Production	Exports
1960	2.94		
1961	3.52		
1962	6.69		
1963	6.63		
1964	8.86		
1965	7.24	1.28	1.26
1966	8.53	1.47	1.30
1967	9.82	1.82	1.56
1968	10.26	1.92	2.08
1969	8.96	1.61	1.66
1970	12.28	2.25	1.87
1971	10.28	1.93	1.75
1972	4.45	0.90	1.53
1973	1.77	0.42	0.35
1974	3.58	0.91	0.63
1975	3.10[1]	0.69[1]	0.75[1]
1976	4.0-4.5[2]	0.90-1.00[2]	N.A.

[1]Preliminary.
[2]Projection.
Sources: FAO Yearbook of Fishery Statistics (1960-73 data). U.S. Department of Agriculture World Agricultural Production and Trade: Statistical Report, August 1975 (1974 data). U.S. Embassy, Lima (1975-76 data).

Table 4.—Fish meal exports by country, 1973-75, in 1,000 metric tons.

Country	1975[1]	1974	1973
Socialist countries	296.5	291.8	108
Federal Republic of Germany	159.3	108.0	76
United States	62.2	32.9	22
Latin America	59.6	25.8	25
Cuba	43.7	17.0	8.5
Netherlands and Belgium	30.1	49.6	30
Italy	25.6	12.4	25
Other	70.6	94.0	56
Total[2]	747.6	631.5	351

[1]Preliminary.
[2]Totals may not agree due to rounding.
Source: *Oil World Weekly.*

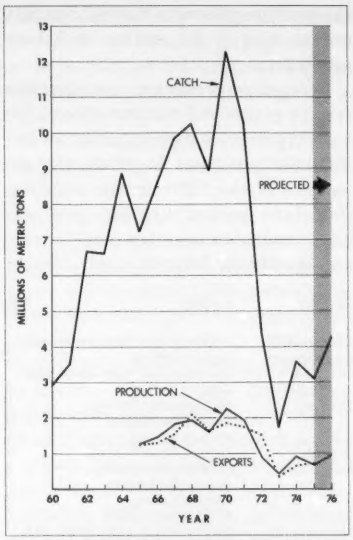


Figure 1.—Anchovy catch, 1960-76, and fish meal production and exports, 1965-76.

Because of the large anchovy fishery, Peruvian fishers caught a greater quantity of fish than any other country's fishers from 1962-1971. As a result of the greatly reduced Peruvian anchovy catch, Japan, the Soviet Union, China[1], Norway, and the United States reported larger fishery catches in 1973.

As would be expected, with the declining anchovy catches the production and exportation of fish meal has also declined from a peak reached in 1970 when 2.25 million metric tons were produced and 1.87 million metric tons were exported (Fig. 1).

The 1975 fish meal production of 690,000 metric tons was only 31 percent of the record 2.3 million metric tons produced in 1970. Fish meal ex-

[1]Based on FAO data which are at best guess-estimates. The People's Republic of China does not publish its fishery catch statistics.

ports of 750,000 metric tons were only 40 percent of the 1.91 million metric tons exported in 1970. The largest share of Peruvian fish meal exports is shipped to the socialist countries which accounted for nearly 300,000 metric tons or 40 percent of total fish meal exports in 1975. The Federal Republic of Germany, the United States, and Cuba also imported significant quantities of Peruvian fish meal in 1975 (Table 4).

Iceland, United Kingdom Reach Fishery Agreement

Iceland and the United Kingdom have signed a six-month fisheries agreement ending the so-called "Cod War" over British fishing rights in Icelandic waters. Meetings leading to the agreement were held in Oslo, Norway on 30-31 May, after Britain had withdrawn its frigates and trawlers from the disputed waters at Iceland's insistence. On 1 June, British Foreign Secretary Crosland and Icelandic Foreign Minister Augustsson announced that an agreement had been reached. It became effective on 2 June and will last until 1 December 1976.

Iceland extended its fisheries jurisdiction from 50 to 200 miles on 15 October 1975, and the dispute with Britain began on 13 November 1975, when a two-year fisheries agreement between the two nations expired (Fig. 1). Britain sent naval frigates and other vessels into Icelandic-claimed waters to protect British trawlers, which were being harassed by Icelandic gunboats. During the seven months of the "Cod War," British frigates and trawlers clashed more than 40 times with the Icelandic Coast Guard patrol vessels which were trying to enforce a 200-mile fishing limit. The dispute eventually led to the breaking of diplomatic relations in February 1976, the first such event between two members of the North Atlantic Treaty Organization (NATO) since the founding of that body in 1947.

The agreement limits the number of British trawlers fishing within the Icelandic 200-mile fisheries zone to an average of 24 vessels per day. This number will be counted on a monthly basis, but not more than 29 trawlers will be allowed to fish on any given day. Britain is required to provide the names of all trawlers operating off Iceland, and to fish no closer than 20 to 30 miles from the coast, depending on the limits in specific fishing areas. The British are required to report the positions and catches of their trawlers to the Icelanders, who have the right to stop them and investigate alleged violations. Additionally, the United Kingdom has promised to observe certain "no fishing" zones where Iceland prohibits its own vessels from fishing.

Figure 1.—Iceland's fishery limits.

The United Kingdom has also promised to ask the European Economic Community (EEC) to implement its 1972 agreement with Iceland which lowers tariffs between Iceland and the EEC, and which would apply to significant fishery exports from Iceland to EEC. Britain, however, will advise the EEC that the agreement should last for only 6 months, unless a permanent agreement is reached.

While no catch quotas were announced, Iceland expects British trawlers to land approximately 30,000 metric tons of fish (85 percent cod, 15 percent other species) during the next six months. The United Kingdom landed over 130,000 metric tons from Icelandic waters in 1975 and consistently refused Iceland's offer of an annual quota of 60,000 metric tons, but apparently reduced its demands because of growing pressures from both Iceland and NATO. Negotiations for a permanent agreement to follow this one are expected to begin after the return of the Icelandic ambassador to London and the resumption of diplomatic relations. Iceland, however, can be expected to continue to restrict British fishing in its waters, and will reportedly seek to limit the catch to 35,000 metric tons annually. (Source: U.S. Embassy Oslo, and others.)

The NMFS Office of International Fisheries reports that Iceland's Foreign Minister Augustsson pointed out at a press conference that British vessels will fish in Iceland's waters "only to the extent provided for in arrangements agreed (upon by) the Government of Iceland," and called this British recognition of Iceland's 200-mile limit. Britain's Foreign Secretary Crosland called the agreement a victory for common sense, but newspapers in the United Kingdom regarded it as more of a victory for Iceland. Industry reacted strongly: A spokesman for the British Trawlers' Federation was quoted as saying, "We expected the worst. This is the worst." Both Augustsson and Crosland praised Norway's Foreign Minister Frydenlund and NATO Secretary General Luns for their help.

The British would have probably received better terms if they had settled in November 1975 without sending in the Royal Navy. The bitterness generated by this third "Cod War" will have a detrimental effect on future negotiations. Certain political factions in Iceland will attempt to curtail Britain's fishing entirely when this agreement expires in December.

When negotiations began, 42 British trawlers were operating off Iceland, but as many as 140 had fished there at one time during 1975. The reduction to 24 vessels per day will have a serious effect on the British deep-sea fleet, and the British Government has promised to compensate fishers affected by the reduction of fishing effort.

World Fisheries Developments Noted

The Division of International Fisheries Analysis, which follows trends in world fisheries for the National Marine Fisheries Service (NMFS), has prepared the following summary of the significant developments in world fisheries.

The U.S. Coast Guard boarded a Danish vessel east of Georges Bank on 14 May and cited it for violation of an ICNAF High Seas Abstention Area. The vessel was longlining for sharks

and had 100 tons of headless frozen shark.

Russia has formally protested U.S. legislation establishing a 200-mile fishery zone. In a note to the U.S. Department of State, the Soviets indicated that they view the unilateral action by the United States as a hindrance to the U.N. Law of the Sea Conference.

Thursdays have been declared "no-meat" days in the USSR to increase per capita consumption of fish and dairy products. Soviet meat reserves have been low due to a large-scale slaughtering of livestock following last summer's drought and subsequent feed shortage.

Russia is producing artificial caviar which reportedly tastes "just like the real thing." The caviar, made from milk albumin, casein, oils, fish, fats, salt, and water, is produced by a machine with a capacity of 400 pounds a day.

Britain's Minister of State at the Foreign Office Roy Hattersley told the European Communities (EC) Council of Ministers on 5 May that any EC common fisheries policy must allow the United Kingdom a fishing zone with limits of up to 50 miles.

Publications

Russian-English Marine Glossary and Electrical Fishing Volumes Published

The Russian-English Glossary of Fishing and Related Marine Terms was compiled in 1975 by Menakhme Ben-Yami for Keter Publishing House, Ltd., Jerusalem, Israel. It is arranged alphabetically by Russian terms and contains an English index, a list of Russian abbreviations, several drawings and photographs of fishing gear and other equipment for which no counterparts exist in the West, and an extensive bibliography. The majority of the terms were compiled by Ben-Yami, Chief, Fisheries Technology Unit, Israeli Department of Fisheries, over a period of 14 years. Milton M. Rose, Chief, Language Services Division, and Jerry E. Jurkovich, Gear Research Unit, Northwest Fisheries Center, both of NMFS, NOAA, and T. S. Sealy, Director, MARTRAN, Ltd., United Kingdom, aided in the compilation. The 182-page glossary is available from Halstead Press, John Wiley and Sons, 605 Third Avenue, New York, NY 10016, at $18.00 per copy.

Electrical Fishing: Theory and Practice, by V. Sternin, I. Nikonorov, and Yu. Bumeister, "Pishchevaia promyshlennost" Publishers, Moscow, 1972. This Russian book was recently translated in Israel under the auspices of the U.S.-Israel Binational Science Foundation. The book is made up of two parts. The first part deals with the electric field of currents in electrical fishing. The subject matter includes electrical conductivity of natural waters, electrochemical phenomena on the surface of electrodes, electrical field of point and line current sources, electrical field of current between electrodes with simple geometric shapes, electrical conductivity between electrodes, and electrotechnical calculations for alternating and pulsating current. The second part deals with biotechnical foundations of electrical fishing. The book is available on loan from F43, Language Services Division, Office of International Fisheries, NMFS, NOAA, Washington, DC 20235.

Texas A&M Prints Shrimp Thermal Tolerance Study

A study of the thermal tolerance and acclimation rate of postlarval shrimp has been published by Texas A&M University. Entitled **"Thermal Resistance and Acclimation Rate in Young White and Brown Shrimp, *Penaeus setiferous* Linn. and *Penaeus aztecus* Ives,"** it was written by Larry M. Wiesepape of the University's Department of Wildlife and Fisheries Sciences.

Brown shrimp postlarvae, acclimated at 24, 29, and 34°C, were tested for thermal resistance at five lethal temperatures for each acclimation temperature (34-38°C, 35-39°C, and 36-40°C). White shrimp postlarvae acclimated at 29°C and 34°C were tested for thermal resistance at six lethal temperatures for each acclimation temperature (35-40°C and 36-40°C). The temperature which caused 50 percent mortality at 10,000 minutes was between 35°C and 36°C for postlarvae acclimated at 24°C and between 36°C and 37°C for those acclimated at 29°C and 34°C. Twenty-four-hour LC_{50}'s were 36.3°C, 37.5°C, and 38.3°C respectively, and 38.3°C and 38.9°C for white shrimp postlarvae acclimated at 29°C and 34°C respectively. Postlarval brown shrimp were reported more resistant at most lethal temperatures than were 30-mm brown shrimp. Postlarval and 30-mm white shrimp had similar resistance times, which were greater than those of 50-mm white shrimp.

Separate groups of white and brown shrimp postlarvae were acclimated at six temperature and salinity combinations (29°C and 34°C; and 25, 35, and 45 parts per thousand) and were tested for thermal resistance at each of these and two lethal temperatures. Thermal resistance was greatest at a test salinity of 25 parts per thousand. However, acclimation to a higher or lower salinity gave maximum protection against heat death at that salinity and at all salinities closer to 25 parts per thousand.

The 196-page paperbound volume has 69 figures and 10 tables. It is available from the Center for Marine Resources, Texas A&M University, College Station, TX 77843 for $4.00 each. Orders should include the publication number, TAMU-SG-76-202.

British Books Describe Small-Scale Fishing Gear, Eel Industry

"Eel Capture, Culture, Processing, and Marketing" by David M. Forrest examines virtually all facets of the eel industry, as its title suggests. Interest in eeling and eel farming is growing, says the author, who has worked extensively with eel capture, processing, and marketing in Europe, Japan, Taiwan, and Australia. Eel markets are reportedly worth over $150 million overall.

Nontechnical, the book provides a general overview of eels, eeling techniques, and eel culture and marketing in Europe, America, New Zealand, and parts of Asia. Most emphasis, though, is on Europe, Taiwan, and Japan where eels are most popular. Five distinct areas of eel operations are

identified: Elvers, fingerling eels, captured wild eels, cultured eels, and fresh and processed eels.

This is a good general guide to the eel industry. Its information is arranged in five sections: Elver capture, holding, and marketing; eel culture; eel capture; eel processing; and eel marketing. For those wanting more technical or in-depth information, numerous references are cited. The text is supplemented with 66 photographs, 24 charts, and 49 tables. Of small (6 x 8½ inches) format, the book has 205 pages. It is published by Fishing News (Books) Ltd., 23 Rosemount Ave., West Byfleet, Surrey, England, and costs £7.25.

Another new book, the **"FAO Catalog of Small Scale Fishing Gear,"** edited by C. Nedelec, has also been published by Fishing News (Books) Ltd. by arrangement with the Food and Agriculture Organization of the United Nations. It is aimed at commercial fishers, fishing gear makers, fishery instructors and extension workers, and the like. Text, in English, French, and Spanish, is at a minimum; most of the book is devoted to drawings of the various types of gear.

Gear construction and operation is emphasized. In its 191 pages the book illustrates a fairly representative selection of gear proven by commercial fishers in many nations. Items shown from the United States include a Buzzards Bay, Mass. lobster pot, a Puget Sound (Wash.) salmon gillnet, and a "surround net" (lampara) used in California to catch live bait. Maximum size of fishing vessels shown is about 15 meters long, with engines of up to 150 horsepower. Other gear described include scoop nets, longlines, trolling gear, handlines, fyke nets, pots, traps, driftnets, liftnets, dredges, trawling gear, seines, etc. The book costs £7.75 and is available from the publisher.

Fishery Translations Available on Loan

The articles and papers listed below have been translated by the Language Services Division of the National Marine Fisheries Service's Office of International Fisheries, unless otherwise noted. Copies of the full translations are available on loan from that office (F43), National Marine Fisheries Service, NOAA, Washington, DC 20235.

Nichiro Joins in Krill Harvesting, from the 25 May issue of *Suisan Shuho* (No. 771) reports that the Nichiro Gyogyo Company plans to harvest Antarctic krill this fall. In the past they have canned tiny shrimp (*Penacopsis akaebi*) for the market and expect to successfully process krill. The four largest Japanese fishing companies (Taiyo, Nippon Suisan, Nichiro, and Kyokuyo) will all fish for krill this fall.

Japanese Fishing Industry Use of Fuel Oil, from *Suisan Shimbun,* No. 3710, 31 March, notes that 11 major Japanese fishing companies used 1,186,000 kiloliters of fuel oil, or 22 percent of the total 5,500,000 kiloliters used in 1975. Small and medium-sized companies and coastal fishers used the remainder, 4,314,000 kiloliters.

Gonadal development, structure, and maturity of female *Loligo pealei* are described in **Questions of Ogenesis of Atlantic Longfin Squid (*Loligo pealei* Les.) of Georges Bank,** by P. N. Burukovskii and A. N. Vovk. The article was translated from the *Archive of Anatomy, Histology, and Embryology* (Vol. 66, No. 5, 1974) by Canada's Multilingual Services Division.

Other NMFS translated articles include: **Japanese Fish Catches Within 200 Miles of Foreign Shores,** from *Suisan Shimbun,* No. 3515, 14 April; **Whaling Season Begins,** from *Suisan Shuho,* No. 711, 25 May; **Good Shrimp Catches at the Amazon River Mouth,** from *Suisan Shuho,* No. 768, 15 April; **Nichiro Forsees a Modest Profit This Year,** from *Suisan Shuho,* 5 March (the company lost almost 20 billion yen in 1974-75); **(Japanese) Fishery Agency Budget,** from *Suisan Shuho,* No. 761, 25 January (the 141,705 billion yen budget represents 6 percent of the total Agriculture and Forestry Ministry budget and a 22 percent increase); **A New Order for the Oceans,** in the 11 March issue of *Asahi Shimbun,* summarizes various Law of the Sea issues.

Other available translations are **Reports on Fur Seal, Sea Lion, and Sea Otter Conservation and Harvesting,** a report on the Conference on the Efficient Organization of Fur Seal Conservation in Moscow, 28-30 January 1975 (Referativnai Informatsiia, Series No. 1, Issue No. 6); **Achievements of the 20th Soviet Antarctic Expedition,** from *Sovetskaia Latviia,* Vol. 94, No. 10089, 22 April 1976; **USSR-Japan Negotiations Seen as Reflecting the LOS Philosophy,** an editorial from *Asahi Shimbun,* No. 32462, 1 May 1976; **Exports of Fresh Chinese Prawns to Japan,** from *Minato Shimbun,* No. 8648, 22 April 1976; **Krill Meal as Livestock Feed,** from *Suisan Shuho,* No. 770, 5/15 May 1976; and **Porpoise Population Control,** from *Suisan Keisai Shimbun,* 5 February 1976.

Others are **Importance of Coastal Fishing Grounds,** from *Asahi Shimbun,* 8 March 1976; **Krill: From Research to Harvest,** from *Minato Shimbun,* No. 8579, 30 Janaury 1976; **Status of Fur Seal Stocks** (on the Tyuleniy, Commander, and Kuril Islands) from the USSR Ministry of Fisheries; **Status of the Shrimp Stocks in the Bering Sea,** by V.G. Ivanov in Proceedings of the All-Union Research Institute of Marine Fisheries and Oceanography (VNIRO), Vol. 99, 1974; **Fish Price Stabilization Fund,** from *Suisan Shuho,* No. 762, 5 February 1976 (Japan aims to stabilize fish prices); **A New Japanese Plant for Fish Protein Concentrate (FPC),** from *Nippon Suisan Shimbun,* 6 February 1976; **Alaska Pollock Wastefully Used,** a series of six articles from *Asahi Shimbun* in early 1976 on Japanese fish eating habits and fish use; and **"Fransov," the First Combined Franco-Soviet Fishing Company,** from *France Peche,* No. 205, November 1975.

Other translations include **Japanese Efforts to Harvest Antarctic Krill,** from *Suisan Shuho,* No. 752, 5 October 1975; **Description of Soviet Fishing Vessels,** a series of 11 short articles from *Sudostroenie,* Vol. 7, July 1975; **Capelin Investigations in the Barents Sea in September-October 1975,** from *Fiskets Gang,* Vol. 62, No. 7, February 1976; **Sardinella Fishing by a Dutch Fleet off Mauritania in 1971 and 1972,** from an article titled "Information on the Fishing Coast of Mauritania" in the *Bulletin of the Fishing Laboratory of Nouadhibou,* No. 2, December 1973, by J. Maigret and J. Brulhet; **Commercial Feasibility Survey of New Fishing Grounds,** from *Minato Shimbun,* No. 8611, 9 March 1976 (a report of a successful year of experimental fishing by Japan's Center for Marine Fisheries Resource Development); and **Thriving Yellowtail Culture,** from *Minato Shimbun,* No. 8610, 7 March 1976.

Shrimp, Crabs, and Marine Game Fish Records

. . . . With high salinities, low rainfall, and no cold spells, **1976 was hailed an "excellent year for shrimp production" by the Texas Parks and Wildlife Department.** Brown shrimp in Texas bays grew so fast last spring that the department closed the Gulf shrimping season 15 days early on 17 May to allow the young shrimp to migrate out into the Gulf of Mexico. One group of older shrimp began emigrating in mid-May and the second group—even greater in number—was expected to begin emigrating in June or early July . . . .

. . . . **South Carolina's commercial shrimpers began immediate operations** off Georgetown and Horry Counties on 25 May under a new state law, the Wildlife and Marine Resources Department reports. The legislation repealed an earlier law which set 1 June as the opening date for shrimp trawling within the three-mile limit there, bringing the area into line with the remainder of the state. Shrimp trawling had opened 14 May elsewhere off South Carolina and will end on 31 December. The state-wide shrimp opener is set annually by the department after evaluation of shrimp numbers, economic, and other factors . . . .

. . . . **A 58-pound 8-ounce striped bass has been entered in California's 1976** fish and wildlife award program, the Fish and Game Commission has announced. The program provides important biological data while recognizing sportsmen who legally take exceptional freshwater and marine species. The latest entry, a 49-inch female, was taken in the San Joaquin River near Antioch on 25 April. The state record striper, also from the San Joaquin, weighed 65 pounds and was caught 25 years ago . . . .

. . . . **An 85-pound cobia will set a new South Carolina state record if** confirmed, according to the Wildlife and Marine Resources Department. The fish, caught 21 May near Beaufort, tops the previous record by 2½ pounds. A 62-pound king mackerel taken earlier this year has set a new state record and, may also qualify for a world record in the men's 80-pound test line category . . . .

. . . . **A 520-pound, 9 foot 11-inch sand shark has been certified** as a new Texas State record, the Parks and Wildlife Department reports. The shark was taken 4 April on Fish Haven Reef out of Port Aransas in 12 fathoms of water on 130-pound test line. It measured 63 inches in girth. The previous record was a 380-pound, 10-footer taken in 1972. Most sand sharks taken run less than 6 feet long, the department notes . . . .

. . . . **California's commercial anchovy reduction fishing fleet landed** 141,036 tons of fish during the 1975-76 season, according to a preliminary Department of Fish and Game report. Included were 135,752 tons in the southern permit area, compared to 109,919 tons the previous year, and 5,284 tons in the northern permit area, down from 6,669 tons for 1974-75. In the southern permit area fishers were getting $31 per ton of raw fish at season's close, down from the $32.50 per ton at the opening. Northern anchovy prices were $28 per ton and another $2 per ton was to be paid retroactively when cumulative landings reached 6,500 tons . . . .

. . . . **Recreational oyster gatherers are expected to benefit** from an 11,000-bushel stocking of seed oysters on public fishing grounds by South Carolina's Wildlife and Marine Resources Department. Areas seeded include Murrells Inlet, Hamlin Creek, Folly River, and Last End Point (in Beaufort County). The planting was done in part to fulfill a $50,000 contract from the Coastal Plains Regional Commission which required planting at least 6,000 bushels. During the last two years the department planted about 3,000 bushels a year on the public grounds . . . .

. . . . **Some 4,000 adult white shrimp were tagged from 26 April** through 5 May in Louisiana's Caillou Lake (Sister Lake) in Terrebonne Parish by Wildlife and Fisheries Commission biologists, the commission reports. Purpose of the tagging is to evaluate the distribution and migration of white shrimp populations from the Lake to the Gulf of Mexico, said commission director J. Burton Angelle. The shrimp were tagged with two small green discs on either side of the first tail by a slender wire . . . .

. . . . **A 15 April-26 May closure of Puget Sound to Dungeness crabbing** for personal and commercial purposes with pots and traps will become standard procedure in future seasons, according to the Washington State Department of Fisheries. The closure was set to avoid the waste when captured hard-shelled crabs eat the molting, soft-shelled crabs . . . .

. . . . **"Approximately $200,000 a week" was the calico scallop's worth** to the Florida Panhandle fisheries in April and May, reports the Florida Department of Natural Resources. About 10,000 gallons of scallop meats worth $18 per gallon shucked to processors were coming from the Gulf waters off St. George Island to Port St. Joe each week. Boats were bringing in 300-500 bushels per day, at about a gallon of meat per bushel . . . .

. . . . **Paul A. Sandifer has been named** assistant director of South Carolina's Marine Resources Research Institute, reports V. G. Burrell, Jr., Institute director. Sandifer is a crustacean larvae taxonomy specialist and has headed the state's crustacean aquaculture effort for the past 4 years . . . .

. . . . **Cape Fear Technical Institute, Wilmington, N.C., has acquired** its second vessel, the 50-foot steel-hulled *Limulus*, for multidisciplinary marine science training and research, *The Marine Newsletter* reports. The vessel was formerly operated by the Environmental Protection Agency as the *W. H. Hutton*. Under limited charter arrangements it will be available to students from other educational institutions throughout the Coastal Plains Region . . . .

. . . . **Over 6.6 million coho salmon fry and yearlings** have been planted in more than 60 Puget Sound rivers and streams in a cooperative venture with tribal, sport, and commercial fishers, the Washington Department of Fisheries reports. The plantings were in addition to normal hatchery production and all were made in streams that had poor natural coho escapement in the last two years . . . .

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